APPENDIX I

DEVELOPMENT OF LOCOMOTIVE AND COMMERCIAL MARINE EMISSIONS INVENTORY - 1990 TO 2040

DEVELOPMENT OF LOCOMOTIVE AND COMMERCIAL MARINE EMISSIONS INVENTORY - 1990 TO 2040

This appendix provides the detailed documentation of methods and procedures used to develop statewide annual and ozone season daily emissions inventories for commercial marine vessels operating in Texas ports and waterways.

DEVELOPMENT OF LOCOMOTIVE AND COMMERCIAL MARINE EMISSIONS INVENTORY - 1990 TO 2040

COMMERCIAL MARINE EMISSION INVENTORIES FOR ALL TEXAS COUNTIES
TASK 4 – FINAL REPORT

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I. EXECUTIVE SUMMARY

For this project, E.H. Pechan & Associates, Inc. (Pechan) developed statewide annual and ozone season daily (OSD) emissions inventories for commercial marine vessels (CMVs) operating in Texas ports and waterways. Annual and daily inventories were developed for every year between 1990 and 2040. Both controlled and uncontrolled inventories were developed for these time periods. These emission trend inventories allow for an evaluation of the effectiveness of control programs over time.

For this effort, Pechan compiled existing base year data for CMV emissions for the Port of Houston and for other coastal ports and waterways. Growth factors were then applied to base year emissions to estimate inventories for all 51 years of interest. Control factors applied to future year emissions reflect updated Federal standards for both Category 3 and Category 1& 2 engines. Category 3 engines are defined as having displacement above 30 liters per cylinder. Category 1 marine diesel engines are those with per cylinder displacement up to 7 liters, while Category 2 marine diesel engines are those with per cylinder displacement from 7 to 30 liters. For the purpose of this inventory it is assumed that Category 3 engines primarily use residual blends, while Category 1 and 2 engines typically use distillate fuels.

Summary tables in this section provide emission estimates for volatile organic compounds (VOC), oxides of nitrogen (NO_X), carbon monoxide (CO), and particulate matter less than or equal to 2.5 micrometers (PM-2.5). Additional pollutants for which emission inventories were developed include sulfur dioxide (SO_2), particulate matter less than or equal to 10 micrometers (PM-10), and ammonia (NH_3).

Table I-1 presents statewide annual controlled and uncontrolled diesel-fueled CMV inventories by year for VOC, NO_X, CO, and PM-2.5. The emission estimates represent both in-port and underway activities by diesel vessels. The table also provides the percent difference of the controlled inventory relative to the uncontrolled inventory. Note that CO emissions are equivalent for both scenarios as there are no CO emission limits in effect. Figures I-1, I-2, and I-3 present a graphical comparison of uncontrolled and controlled annual statewide diesel vessel emissions for VOC, NO_X, and PM-2.5, respectively. Uncontrolled emissions show variable increases and decreases throughout the 1990 to 2008 time frame (largely due to dredging operations), after which time, emissions generally increase due to the forecasted growth in activity. For the controlled inventories, after 2009 growth in activity is generally offset by reductions from emission standards impacting NO_X, VOC, and PM-2.5, resulting in decreases in emissions over the 2010 to 2040 time frame.

Table I-2 presents statewide annual controlled and uncontrolled residual-fueled vessel inventories for VOC, NO_X, CO, and PM-2.5 for 1990 through 2040, as well as the percent difference. Emission estimates for both CO and VOC are equivalent for controlled and uncontrolled inventories. Figures I-4 and I-5 display charts to show the relative trends in uncontrolled and controlled annual statewide Category 3 emissions for NO_X and PM-2.5, respectively. After 2015, NO_X emission standards offset increases in growth and reductions are realized for each year out to 2040. PM-2.5 emissions for residual-fueled ships show significant decreases in 2010 and 2015 due to the lower fuel sulfur levels required for Category 3 engines in

those years, and after 2015 shows a gradual increase similar to VOC and CO due to steady growth projected out to 2040.

Calendar years 2002, 2008, 2011, 2012, and 2013 were identified by the TCEQ as particular years of interest for nonattainment area modeling. Table I-3 display area-wide annual CMV emissions for all counties in the Houston-Galveston-Brazoria (HGB) nonattainment area for these select years. For diesel-fueled vessels, slight emission reductions that increase over time begin to be realized for VOC, NO_X, and PM-2.5 during this time period. Residual-fueled vessels show even more significant NO_X reductions, as well as large reductions in PM-2.5 due to Federal fuel sulfur level standards required in 2010.

OSD emission estimates are presented in the "Emissions Summaries" section of this report, and follow the same trend as the annual emission estimates. OSD emissions were estimated from annual emissions assuming that 25 percent of the annual CMV activity occurs during the summer ozone months.

Table I-1. Uncontrolled and Controlled Diesel-Fueled CMV Emissions by Year for the State of Texas

	Uncontrolled Emissions, tpy				Controlled Emissions, tpy				% Difference			
Year	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI
1990	165.40	8,060.40	983.03	203.86	165.40	8,060.40	983.03	203.86	0%	0%	0%	0%
1991	237.75	12,334.16	1,384.65	276.61	237.75	12,334.16	1,384.65	276.61	0%	0%	0%	0%
1992	254.76	13,294.81	1,481.97	293.79	254.76	13,294.81	1,481.97	293.79	0%	0%	0%	0%
1993	203.44	10,149.48	1,203.37	242.68	203.44	10,149.48	1,203.37	242.68	0%	0%	0%	0%
1994	238.35	12,156.43	1,398.94	279.18	238.35	12,156.43	1,398.94	279.18	0%	0%	0%	0%
1995	190.04	9,191.86	1,137.02	231.14	190.04	9,191.86	1,137.02	231.14	0%	0%	0%	0%
1996	214.20	10,650.28	1,270.10	254.44	214.20	10,650.28	1,270.10	254.44	0%	0%	0%	0%
1997	250.92	12,637.35	1,483.02	293.43	250.92	12,637.35	1,483.02	293.43	0%	0%	0%	0%
1998	232.66	11,514.57	1,385.02	274.34	232.66	11,514.57	1,385.02	274.34	0%	0%	0%	0%
1999	450.82	24,722.11	2,578.37	491.52	450.82	24,722.11	2,578.37	491.52	0%	0%	0%	0%
2000	268.06	13,408.97	1,591.08	311.33	268.06	13,408.97	1,591.08	311.33	0%	0%	0%	0%
2001	259.44	12,935.42	1,542.70	301.48	259.44	12,935.42	1,542.70	301.48	0%	0%	0%	0%
2002	311.62	16,171.75	1,825.05	352.18	311.62	16,171.75	1,825.05	352.18	0%	0%	0%	0%
2003	345.83	18,050.72	2,021.54	389.97	345.83	18,050.72	2,021.54	389.97	0%	0%	0%	0%
2004	209.64	9,715.26	1,279.47	255.78	209.64	9,715.26	1,279.47	255.78	0%	0%	0%	0%
2005	158.75	6,586.01	1,006.06	203.35	158.75	6,586.01	1,006.06	203.35	0%	0%	0%	0%
2006	148.71	5,817.09	957.64	193.91	148.71	5,817.09	957.64	193.91	0%	0%	0%	0%
2007	129.80	4,789.31	849.60	175.01	129.80	4,789.31	849.60	175.01	0%	0%	0%	0%
2008	144.42	5,698.18	927.51	189.93	144.42	5,641.20	927.51	188.03	0%	-1%	0%	-1%
2009	203.74	9,091.30	1,264.15	250.08	203.74	8,909.47	1,264.15	245.08	0%	-2%	0%	-2%
2010	315.84	15,772.63	1,884.36	362.84	315.84	15,299.45	1,884.36	351.95	0%	-3%	0%	-3%
2011	318.89	15,865.32	1,904.84	366.49	318.89	15,230.70	1,904.84	351.83	0%	-4%	0%	-4%
2012	320.91	15,926.09	1,919.63	368.87	317.70	15,129.79	1,919.63	346.74	-1%	-5%	0%	-6%
2013	324.62	16,036.16	1,943.76	373.13	318.13	15,073.99	1,943.76	339.55	-2%	-6%	0%	-9%
2014	325.36	16,061.45	1,951.50	374.41	309.09	14,615.92	1,951.50	329.48	-5%	-9%	0%	-12%
2015	327.75	16,132.14	1,968.36	377.14	301.53	14,357.61	1,968.36	328.11	-8%	-11%	0%	-13%
2016	329.88	16,197.14	1,983.77	379.82	290.30	14,091.51	1,983.77	319.05	-12%	-13%	0%	-16%
2017	331.56	16,248.72	1,996.70	381.88	278.51	13,648.93	1,996.70	305.51	-16%	-16%	0%	-20%
2018	334.37	16,334.29	2,015.85	385.28	264.16	13,067.43	2,015.85	296.67	-21%	-20%	0%	-23%
2019	336.77	16,409.79	2,032.67	388.41	252.57	12,635.54	2,032.67	287.42	-25%	-23%	0%	-26%
2020	340.15	16,510.17	2,055.01	392.19	241.51	12,217.52	2,055.01	278.46	-29%	-26%	0%	-29%
2021	342.27	16,574.04	2,070.35	394.73	229.32	11,767.57	2,070.35	268.42	-33%	-29%	0%	-32%
2022	344.39	16,637.89	2,085.70	397.26	216.97	11,147.38	2,085.70	254.25	-37%	-33%	0%	-36%
2023	346.51	16,701.74	2,101.04	399.80	204.44	10,689.11	2,101.04	243.88	-41%	-36%	0%	-39%
2024	348.62	16,765.59	2,116.39	402.34	191.74	10,227.01	2,116.39	233.36	-45%	-39%	0%	-42%
2025	350.74	16,829.44	2,131.74	404.87	182.39	9,761.07	2,131.74	222.68	-48%	-42%	0%	-45%

	Uncontrolled Emissions, tpy				Controlled Emissions, tpy				% Difference			
Year	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI
2026	352.86	16,893.28	2,147.08	407.41	172.90	9,291.31	2,147.08	211.85	-51%	-45%	0%	-48%
2027	354.98	16,957.13	2,162.43	409.95	163.29	8,817.71	2,162.43	200.87	-54%	-48%	0%	-51%
2028	357.10	17,020.98	2,177.77	412.48	153.55	8,510.49	2,177.77	193.87	-57%	-50%	0%	-53%
2029	359.21	17,084.83	2,193.12	415.02	147.28	8,029.87	2,193.12	182.61	-59%	-53%	0%	-56%
2030	361.33	17,148.68	2,208.46	417.55	140.92	7,716.91	2,208.46	175.37	-61%	-55%	0%	-58%
2031	363.45	17,212.53	2,223.81	420.09	134.48	7,401.39	2,223.81	163.84	-63%	-57%	0%	-61%
2032	365.57	17,276.38	2,239.15	422.63	131.60	7,083.32	2,239.15	156.37	-64%	-59%	0%	-63%
2033	367.68	17,340.23	2,254.50	425.16	125.01	6,936.09	2,254.50	148.81	-66%	-60%	0%	-65%
2034	369.80	17,404.08	2,269.84	427.70	122.03	6,613.55	2,269.84	141.14	-67%	-62%	0%	-67%
2035	371.92	17,467.91	2,285.19	430.23	119.01	6,463.13	2,285.19	137.67	-68%	-63%	0%	-68%
2036	374.13	17,534.71	2,301.02	432.89	115.98	6,137.15	2,301.02	129.87	-69%	-65%	0%	-70%
2037	376.33	17,601.48	2,316.85	435.55	112.90	5,984.50	2,316.85	126.31	-70%	-66%	0%	-71%
2038	378.54	17,668.26	2,332.68	438.20	109.78	6,007.21	2,332.68	118.31	-71%	-66%	0%	-73%
2039	380.74	17,735.04	2,348.51	440.86	110.42	5,852.56	2,348.51	114.62	-71%	-67%	0%	-74%
2040	382.95	17,801.79	2,364.34	443.51	111.06	5,696.57	2,364.34	115.31	-71%	-68%	0%	-74%

*Calculated as ((Controlled - Uncontrolled)/(Controlled))*100

Figure I-1. Statewide Diesel-Fueled CMV VOC Emissions by Year

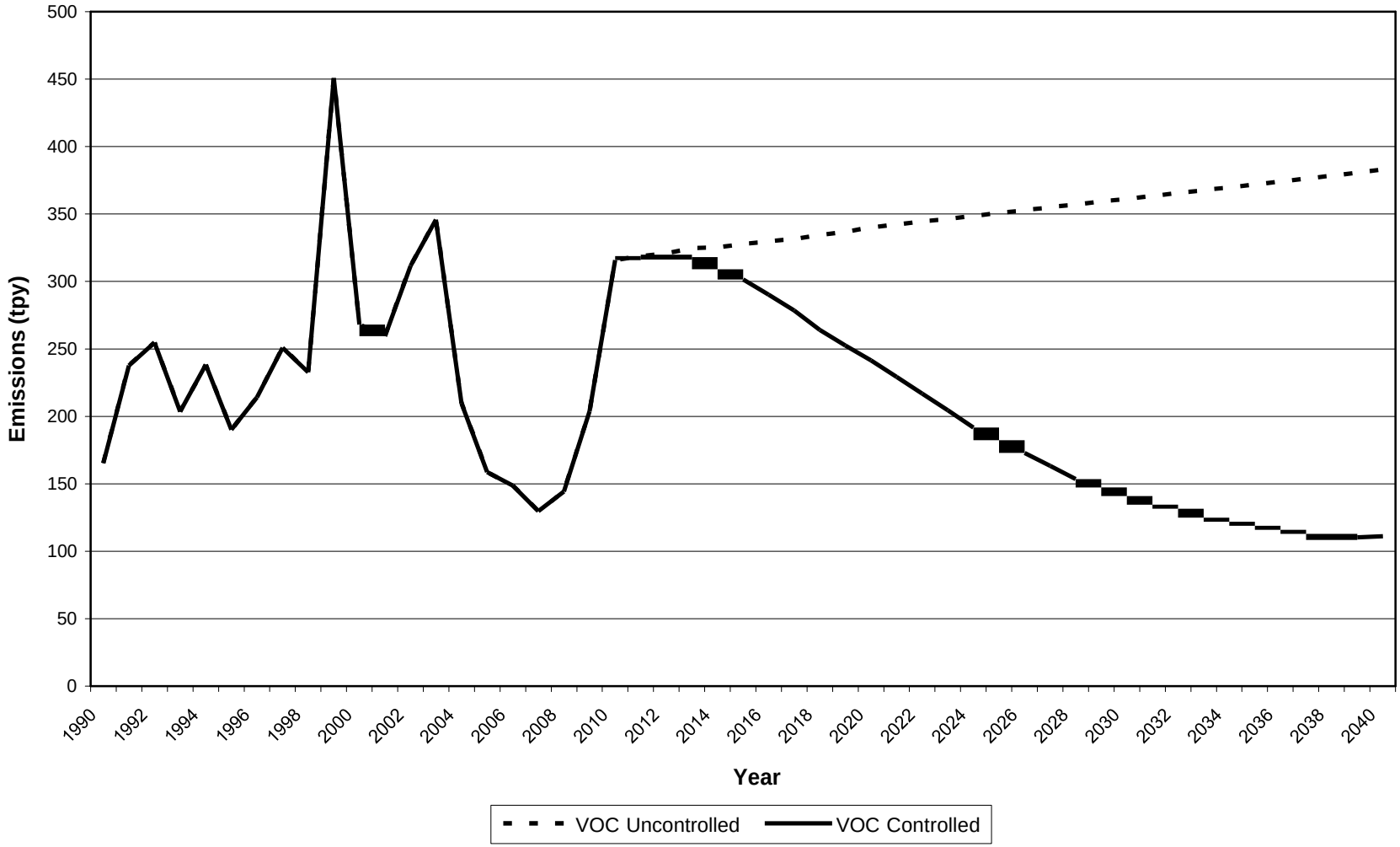

Figure I-2. Statewide Diesel-Fueled CMV NO_X Emissions by Year

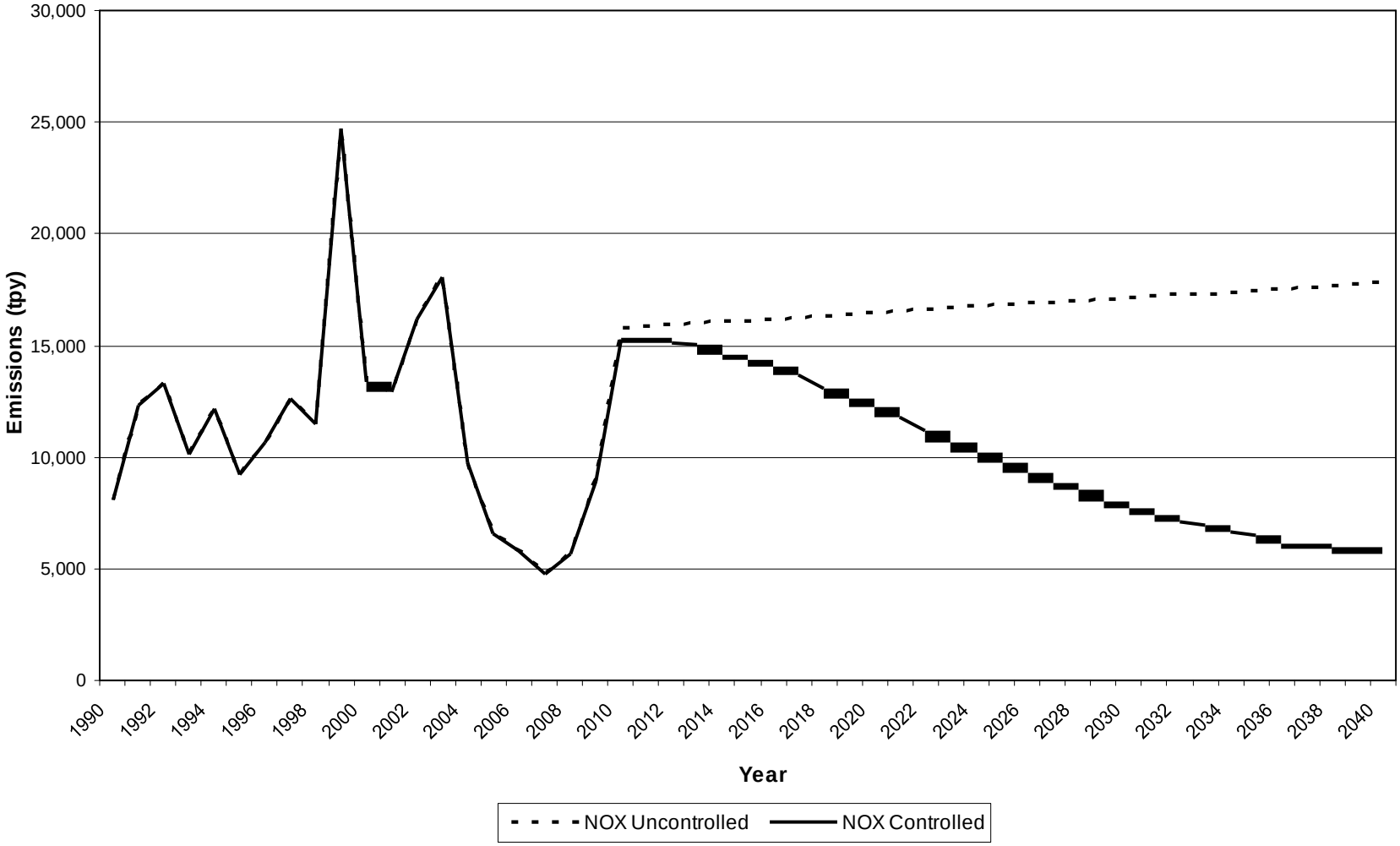

Figure I-3. Statewide Diesel-Fueled CMV PM-2.5 Emissions by Year

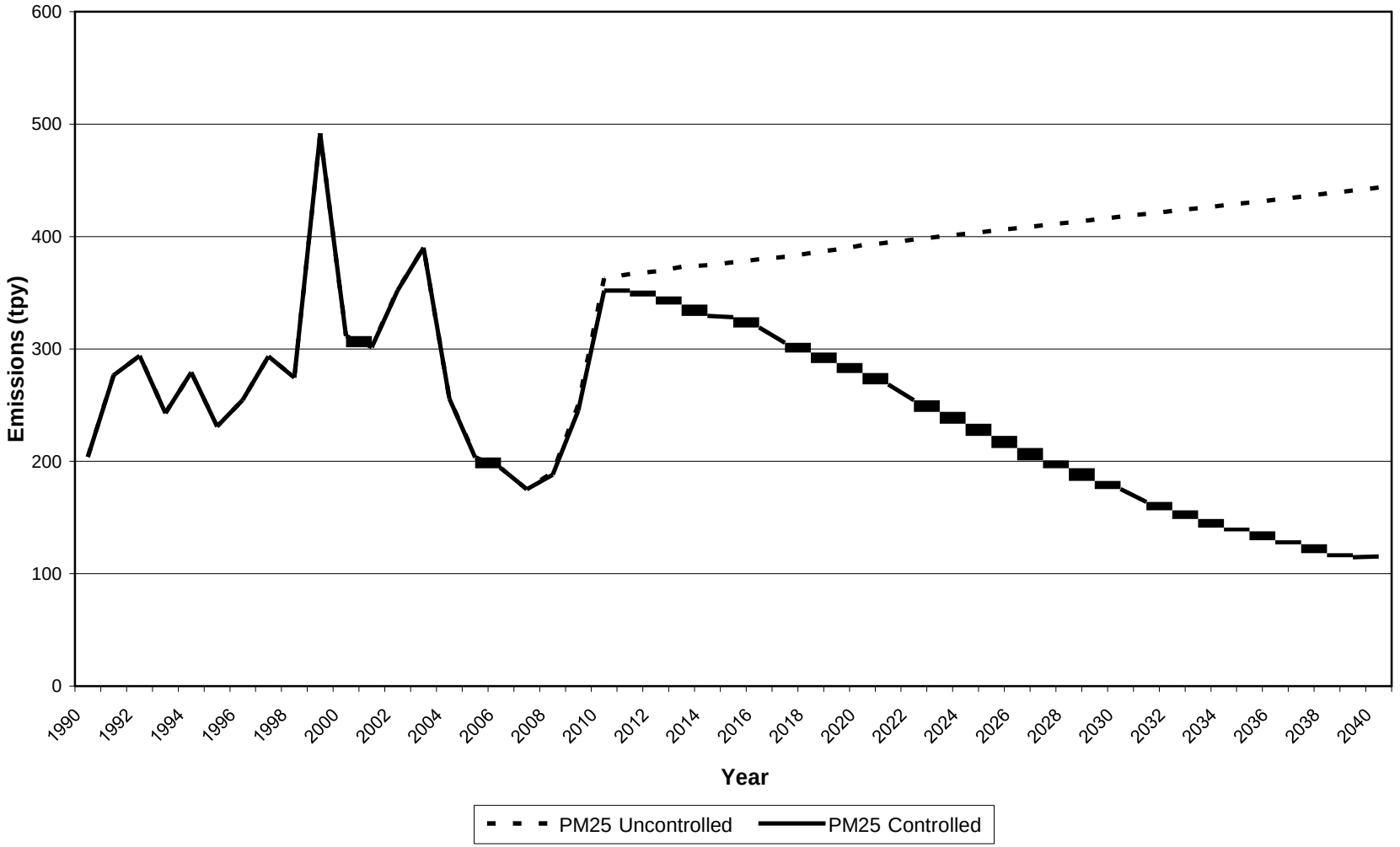

Table I-2. Uncontrolled and Controlled Residual-Fueled CMV Emissions by Year for State of Texas

	Uncontrolled Emissions, tpy				Controlled Emissions, tpy				% Difference			
Year	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI
1990	309.58	9,844.53	818.16	841.14	309.58	9,844.53	818.16	841.14	0%	0%	0%	0%
1991	322.61	10,218.37	849.57	876.89	322.61	10,218.37	849.57	876.89	0%	0%	0%	0%
1992	335.64	10,592.22	880.97	912.63	335.64	10,592.22	880.97	912.63	0%	0%	0%	0%
1993	348.67	10,966.07	912.38	948.37	348.67	10,966.07	912.38	948.37	0%	0%	0%	0%
1994	361.70	11,339.91	943.79	984.11	361.70	11,339.91	943.79	984.11	0%	0%	0%	0%
1995	374.74	11,713.76	975.19	1,019.85	374.74	11,713.76	975.19	1,019.85	0%	0%	0%	0%
1996	377.03	11,824.19	983.47	1,025.98	377.03	11,824.19	983.47	1,025.98	0%	0%	0%	0%
1997	412.54	12,749.57	1,063.30	1,123.71	412.54	12,749.57	1,063.30	1,123.71	0%	0%	0%	0%
1998	421.42	13,021.70	1,085.78	1,148.02	421.42	13,021.70	1,085.78	1,148.02	0%	0%	0%	0%
1999	403.31	12,631.18	1,050.08	1,097.86	403.31	12,631.18	1,050.08	1,097.86	0%	0%	0%	0%
2000	459.51	14,073.81	1,174.88	1,252.70	459.51	14,073.81	1,174.88	1,252.70	0%	0%	0%	0%
2001	458.23	14,091.24	1,175.23	1,248.94	458.23	14,091.24	1,175.23	1,248.94	0%	0%	0%	0%
2002	445.53	13,834.92	1,151.22	1,213.71	445.53	13,834.92	1,151.22	1,213.71	0%	0%	0%	0%
2003	473.26	14,565.20	1,214.18	1,289.98	473.26	14,096.89	1,214.18	1,281.86	0%	-3%	0%	-1%
2004	497.01	15,208.87	1,268.93	1,355.32	497.01	14,618.94	1,268.93	1,346.78	0%	-4%	0%	-1%
2005	517.43	15,758.85	1,316.04	1,411.41	517.43	15,050.29	1,316.04	1,402.52	0%	-4%	0%	-1%
2006	539.52	16,350.08	1,366.77	1,472.14	539.52	15,538.04	1,366.77	1,462.87	0%	-5%	0%	-1%
2007	529.74	16,170.87	1,349.27	1,445.00	529.74	15,238.93	1,349.27	1,435.90	0%	-6%	0%	-1%
2008	523.93	16,077.67	1,339.93	1,428.72	523.93	15,048.33	1,339.93	1,419.73	0%	-6%	0%	-1%
2009	557.22	16,950.19	1,415.03	1,520.36	557.22	15,777.54	1,415.03	1,510.78	0%	-7%	0%	-1%
2010	570.08	17,314.73	1,445.86	1,555.61	570.08	15,094.48	1,445.86	508.74	0%	-13%	0%	-67%
2011	583.41	17,705.32	1,478.29	1,592.22	583.41	15,253.53	1,478.29	520.71	0%	-14%	0%	-67%
2012	596.21	18,066.13	1,508.90	1,627.29	596.21	15,241.70	1,508.90	532.18	0%	-16%	0%	-67%
2013	609.39	18,448.38	1,540.77	1,663.46	609.39	15,255.41	1,540.77	544.01	0%	-17%	0%	-67%
2014	622.32	18,816.19	1,571.91	1,698.87	622.32	15,269.85	1,571.91	555.59	0%	-19%	0%	-67%
2015	635.22	19,182.79	1,602.84	1,734.29	635.22	15,320.95	1,602.84	233.84	0%	-20%	0%	-87%
2016	648.49	19,569.74	1,635.22	1,770.65	648.49	15,208.53	1,635.22	238.75	0%	-22%	0%	-87%
2017	661.25	19,928.74	1,665.61	1,805.64	661.25	14,542.46	1,665.61	243.47	0%	-27%	0%	-87%
2018	674.35	20,306.60	1,697.13	1,841.60	674.35	13,747.18	1,697.13	248.31	0%	-32%	0%	-87%
2019	687.47	20,684.65	1,729.03	1,877.52	687.47	13,020.95	1,729.03	253.16	0%	-37%	0%	-87%
2020	700.52	21,059.93	1,760.37	1,913.36	700.52	12,440.41	1,760.37	260.67	0%	-41%	0%	-86%
2021	713.53	21,432.94	1,791.73	1,949.06	713.53	11,866.57	1,791.73	262.80	0%	-45%	0%	-87%
2022	726.55	21,805.95	1,823.10	1,984.75	726.55	11,454.30	1,823.10	267.62	0%	-47%	0%	-87%
2023	739.57	22,178.96	1,854.47	2,020.45	739.57	10,664.82	1,854.47	272.43	0%	-52%	0%	-87%

	Uncontrolled Emissions, tpy				Controlled Emissions, tpy				% Difference			
Year	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI	VOC	NO_X	CO	PM25-PRI
2024	752.58	22,551.97	1,885.84	2,056.14	752.58	10,054.50	1,885.84	277.24	0%	-55%	0%	-87%
2025	765.60	22,924.99	1,917.20	2,091.84	765.60	9,548.10	1,917.20	282.06	0%	-58%	0%	-87%
2026	778.62	23,298.00	1,948.57	2,127.54	778.62	9,074.92	1,948.57	286.87	0%	-61%	0%	-87%
2027	791.63	23,671.01	1,979.94	2,163.23	791.63	8,712.04	1,979.94	291.68	0%	-63%	0%	-87%
2028	804.65	24,044.02	2,011.30	2,198.93	804.65	8,294.59	2,011.30	296.49	0%	-66%	0%	-87%
2029	817.67	24,417.03	2,042.67	2,234.62	817.67	7,979.86	2,042.67	301.31	0%	-67%	0%	-87%
2030	830.68	24,790.04	2,074.04	2,270.32	830.68	7,658.62	2,074.04	309.41	0%	-69%	0%	-86%
2031	843.70	25,163.05	2,105.40	2,306.01	843.70	7,488.87	2,105.40	310.93	0%	-70%	0%	-87%
2032	856.72	25,536.06	2,136.77	2,341.71	856.72	7,316.00	2,136.77	315.75	0%	-71%	0%	-87%
2033	869.73	25,909.07	2,168.14	2,377.40	869.73	7,151.54	2,168.14	320.56	0%	-72%	0%	-87%
2034	882.75	26,282.08	2,199.50	2,413.10	882.75	6,917.59	2,199.50	325.37	0%	-74%	0%	-87%
2035	895.76	26,655.09	2,230.87	2,448.80	895.76	6,722.36	2,230.87	330.19	0%	-75%	0%	-87%
2036	908.79	27,028.36	2,262.25	2,484.50	908.79	6,490.80	2,262.25	335.00	0%	-76%	0%	-87%
2037	921.81	27,401.64	2,293.63	2,520.21	921.81	6,172.00	2,293.63	339.82	0%	-77%	0%	-87%
2038	934.83	27,774.91	2,325.01	2,555.92	934.83	5,982.92	2,325.01	344.63	0%	-78%	0%	-87%
2039	947.85	28,148.19	2,356.39	2,591.63	947.85	5,886.31	2,356.39	349.45	0%	-79%	0%	-87%
2040	960.87	28,521.47	2,387.77	2,627.34	960.87	5,800.78	2,387.77	354.26	0%	-80%	0%	-87%

*Calculated as ((Controlled - Uncontrolled)/(Controlled))*100

Figure I-4. Statewide Residual-Fueled CMV NO_X Emissions by Year

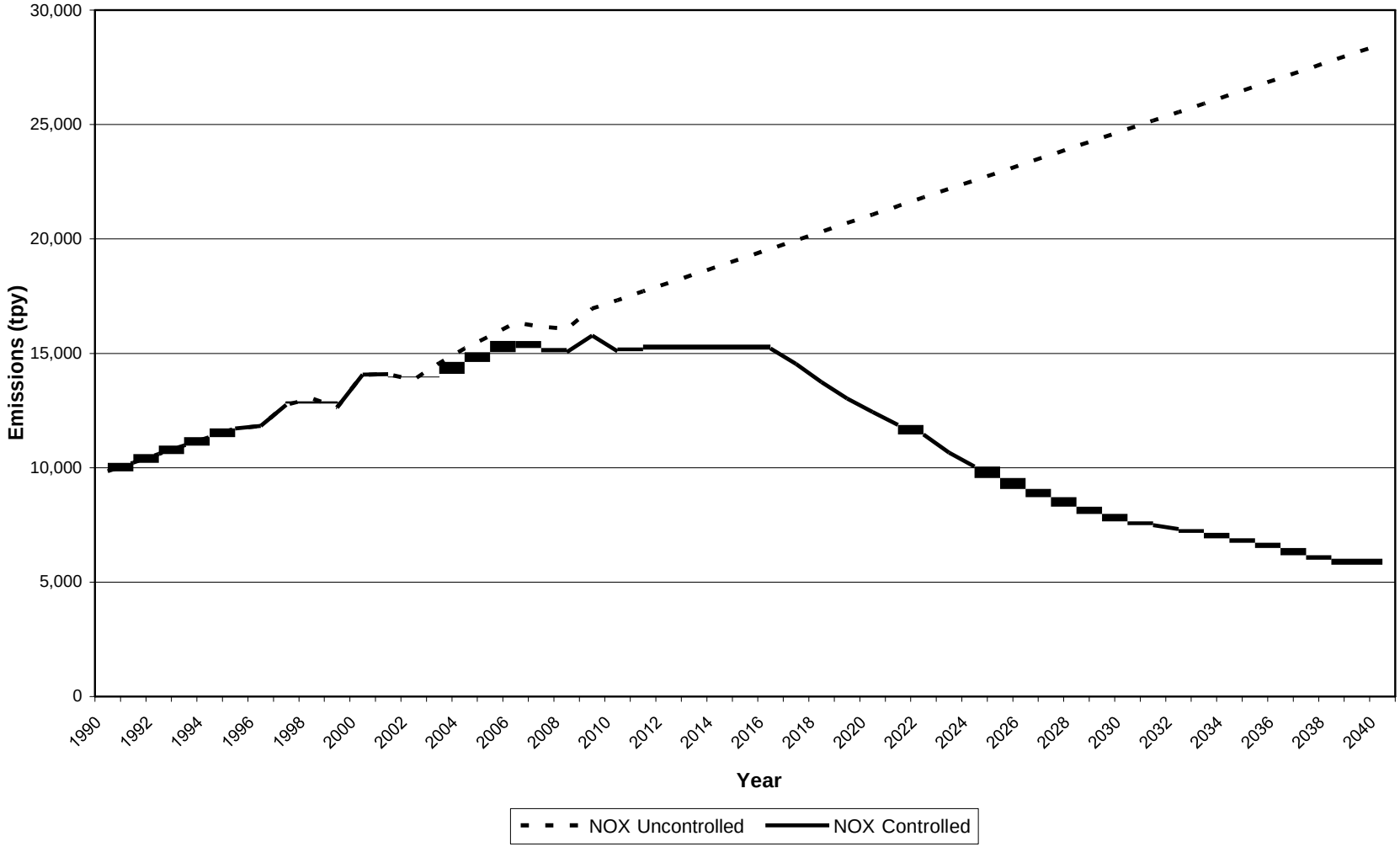

Figure I-5. Statewide Residual-Fueled CMV PM-2.5 Emissions by Year

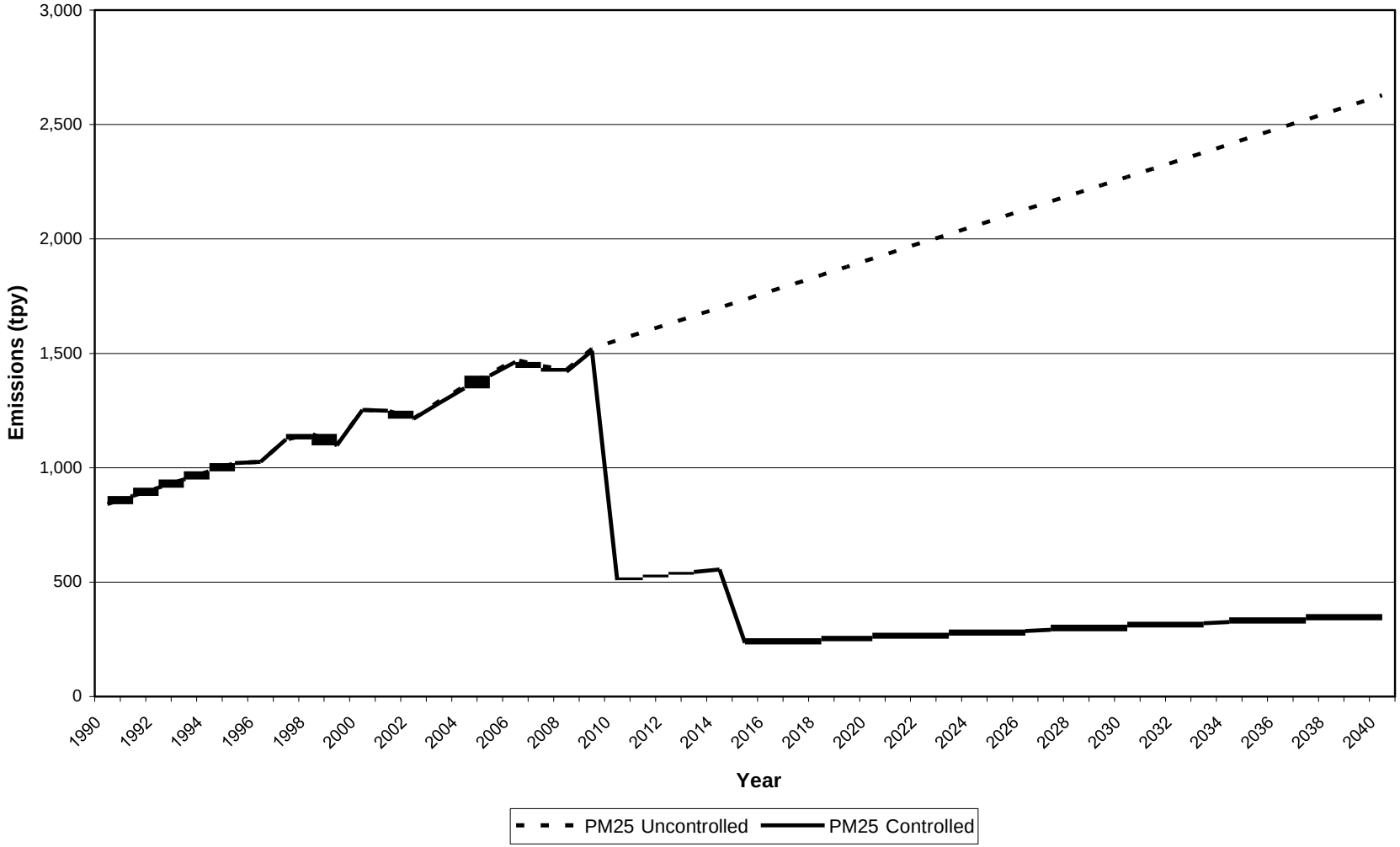

Table I-3. Uncontrolled and Controlled CMV Emissions for HGB Nonattainment Area

		Uncontrolled Emissions, tpy				Controlled Emissions, tpy				% Difference			
Fuel	**Year**	**VOC**	**NO_X**	**CO**	**PM25-PRI**	**VOC**	**NO_X**	**CO**	**PM25-PRI**	**VOC**	**NO_X**	**CO**	**PM25-PRI**
Diesel	2002	137.04	6,334.45	867.56	144.63	137.04	6,334.45	867.56	144.63	0%	0%	0%	0%
Diesel	2008	93.43	3,349.07	649.99	102.42	93.43	3,315.58	649.99	101.39	0%	-1%	0%	-1%
Diesel	2011	171.70	7,751.13	1,098.36	181.67	171.70	7,441.08	1,098.36	174.40	0%	-4%	0%	-4%
Diesel	2012	173.67	7,808.60	1,112.96	183.85	171.94	7,418.17	1,112.96	172.82	-1%	-5%	0%	-6%
Diesel	2013	175.66	7,866.63	1,127.60	186.05	172.15	7,394.63	1,127.60	169.30	-2%	-6%	0%	-9%
Residual	2002	352.80	8,934.42	770.25	973.29	352.80	8,934.42	770.25	973.29	0%	0%	0%	0%
Residual	2008	420.99	10,635.56	918.19	1,161.40	420.99	9,954.63	918.19	1,154.09	0%	-6%	0%	-1%
Residual	2011	475.08	11,976.38	1,035.24	1,310.63	475.08	10,317.93	1,035.24	428.62	0%	-14%	0%	-67%
Residual	2012	486.37	12,257.51	1,059.71	1,341.76	486.37	10,341.19	1,059.71	438.80	0%	-16%	0%	-67%
Residual	2013	497.68	12,540.35	1,084.28	1,372.97	497.68	10,369.92	1,084.28	449.01	0%	-17%	0%	-67%

*Calculated as ((Controlled - Uncontrolled)/(Controlled))*100

II. DEVELOPMENT OF CMV INVENTORIES

The following sections describe how base year emissions, control factors, and growth factors were developed for CMV operations for the State of Texas. For the purpose of this inventory, CMV inventories were reported under the Source Classification Codes (SCCs) specified in Table II-1.

Table II-1. SCCs for Reporting CMV Inventories

SCC	SCC Description
2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280003100	Marine Vessels, Commercial /Residual /Port emissions
2280003200	Marine Vessels, Commercial /Residual /Underway emissions

A. BASE YEAR EMISSIONS

Where available, Pechan used 2007 and/or 2008 SCC, county-level emissions as developed for the most recent 2008 emissions inventory, and documented in the memorandum "Compilation of Activity Data and the Development of Criteria Pollutant Emission Estimates for Commercial Marine Vessels," (ERG, 2009a). Pechan was not tasked to make improvements or refinements to available base year emissions data for CMVs.

Base year emission estimates were obtained from two available reports, including a detailed 2007 Port of Houston study (Starcrest, 2009) and the 2007 Texas State Waters study (ERG, 2009b). Port of Houston emission estimates were available for Brazoria, Chambers, Galveston and Harris counties for the in-port SCCs 2280002100 and 2280003100. The Texas State Waters Study accounted for underway commercial marine operations for Brazoria and Chambers counties, as well as commercial marine activity occurring at all other ports and waterways in Texas (11 additional coastal counties).

Table II-2 lists the specific vessel categories for which emission estimates were initially developed, along with SCC descriptions. The table also lists the diesel or residual, in-port or underway SCC assigned for each specific vessel type for the purposes of applying control factors and reporting the final inventory data. The four SCCs correspond to the Environmental Protection Agency's (EPA) official SCCs for the CMV sector.

The 2007 and 2008 dredging emissions were reported for seven (7) counties. However, dredging also occurred in alternate historic years for 7 other additional counties. Table II-3 lists the counties and the latest base year for which activity and/or emissions were reported. For counties for which zero emissions were reported for 2007 or 2008, Pechan prepared emission estimates for these counties for the appropriate base year, using the reported historical number of dredging days as the activity, (available from ERG/Alliance, 2007). This measure of activity was then coupled with an operating assumption of 21.6 hours per day (i.e., operating 90 percent of the time), and an average horsepower of 7,847. This value represents an average horsepower for both hopper dredges (6,400 hp) and cutter section dredges (9,294 hp). Emission factors consistent with 2007 and 2008 emission inventory calculations were applied to the activity estimates expressed in horsepower-hours.

Table II-2. CMV SCC Description and Correspondence

Specific SCC	SCC Description	General SCC	SCC Description
2280002104	Port emissions: Cruise	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002108	Port emissions: Dry Cargo	2280003100	Marine Vessels, Commercial /Residual /Port emissions
2280002110	Port emissions: Ferry	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002114	Port emissions: Fishing	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002118	Port emissions: Offshore/Support	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002120	Port emissions: Pilot boat	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002122	Port emissions: Tanker	2280003100	Marine Vessels, Commercial /Residual /Port emissions
2280002124	Port emissions: Tug, Assist	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002126	Port emissions: Tug, Line	2280002100	Marine Vessels, Commercial /Diesel /Port emissions
2280002128	**Port emissions: Research**	**2280002100**	**Marine Vessels, Commercial /Diesel /Port emissions**
2280002128	**Port emissions: Other**	**2280003100**	**Marine Vessels, Commercial /Residual /Port emissions**
2280002202	Underway emissions: Container Ship	2280003200	Marine Vessels, Commercial /Residual /Underway emissions
2280002204	Underway emissions: Cruise	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002206	Underway emissions: Dredging	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002208	Underway emissions: Dry Cargo	2280003200	Marine Vessels, Commercial /Residual /Underway emissions
2280002210	Underway emissions: Ferry	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002214	Underway emissions: Fishing	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002216	Underway emissions: Military	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002218	**Underway emissions: Offshore/Support**	**2280002100**	**Marine Vessels, Commercial /Diesel /Port emissions**
2280002218	**Underway emissions: Oil Well Simulation**	**2280002200**	**Marine Vessels, Commercial /Diesel /Underway emissions**
2280002220	Underway emissions: Pilot boat	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002222	Underway emissions: Tanker	2280003200	Marine Vessels, Commercial /Residual /Underway emissions
2280002224	Underway emissions: Tug, Assist	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002226	Underway emissions: Tug, Line	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions
2280002228	**Underway emissions: Other**	**2280002200**	**Marine Vessels, Commercial /Diesel /Underway emissions**
2280002228	**Underway emissions: Reefer**	**2280003200**	**Marine Vessels, Commercial /Residual /Underway emissions**

NOTE: SCCs in bold were designated by subvessel types that were comprised of both diesel and residual fueled vessels.

Table II-3. Texas Counties Reporting Historic Dredging Activity and Associated Base Year

FIPS	County Name	Base Year(s) for Dredging Activity
48007	Aransas	2006
48039	Brazoria	2008
48057	Calhoun	2008
48061	Cameron	2007, 2008
48071	Chambers	2005
48167	Galveston	2008
48201	Harris	2008
48245	Jefferson	2007, 2008
48261	Kenedy	2000
48273	Kleberg	2003
48321	Matagorda	2006
48355	Nueces	2007, 2008
48409	San Patricio	2006
48489	Willacy	2000

B. GROWTH

For years 1999 to 2020, CMV emissions for most ocean-going vessels, fishing vessels, and off-shore support vessels were projected using county-level growth factors developed for TCEQ under a previous contract by ERG and Alliance Transportation Group. Growth factors and the basis for these values are documented in the report, "Development of Commercial Marine Vessel, Locomotive, and Air Traffic Activity Growth Factors," (ERG/Alliance, 2007).

These growth factors were compiled in a database provided by the TCEQ to Pechan (TCEQ, 2010). Specific growth factors were available for tugs, tankers, dry cargo vessels, fishing vessels, and off-shore support vessels. Where there was not a specific match in the growth factor database for a given vessel type, these vessel emissions were forecast or backcast using an average growth factor corresponding to both dry cargo and tanker growth factors. This was the case for ferries, pilot boats, tug assists, and all other vessel types. With the exception of line haul tug emissions, growth factors for 1990 through 1998, and 2021 to 2040 were then estimated by extrapolating the 1999-2020 growth factors to these time periods.

Line haul tugboat emissions were estimated for most historic years using data available from the U.S. Army Corps of Engineers on actual tonnage moved along three portions, or segments of the Gulf Intercoastal Water Way. These data were reported for the years 1992 through 2005 in the ERG/Alliance 2007 report. Counties correspond to segments as follows:

Segment	FIPS	Name
Segment 1	48071	Chambers
Segment 1	48245	Jefferson
Segment 1	48361	Orange
Segment 2	48007	Aransas
Segment 2	48039	Brazoria
Segment 2	48057	Calhoun
Segment 2	48321	Matagorda
Segment 2	48355	Nueces
Segment 2	48409	San Patricio
Segment 3	48261	Kenedy
Segment 3	48273	Kleberg
Segment 3	48489	Willacy

Segment-level growth factors developed from the tonnage data are shown in Table A-1 of Appendix A.

Several CMV categories/areas were projected separately using alternate data sources. Military (Coast Guard) emissions were held constant from 2007 for all years. In-port emissions for the Port of Houston were grown based on Army Corps of Engineers data on total commodity tonnage handled at the Port of Houston (USACE, 2010a). Data were available for years 1996 through 2008, and extrapolated to the outlying years based on the historical trend of these data. This was done in part because in-port data for the Port of Houston were not available at an SCC resolution below SCCs 2280002100 and 2280003100. We also believe port commodity tonnage is a reasonable surrogate for estimating port-related emissions for this time period, and is consistent with ERG's growth methodology from 2007 to 2008. The final growth factors applied to in-port emissions for Port of Houston counties are presented in Table A-2 of Appendix A.

Cruise ship emissions were projected based on an annual average growth rate for the 2007 to 2020 time period of 4.1 percent, as reported by National Ocean Shipping Consultants. This growth rate was applied to all outlying years as well. ERG/Alliance had only estimated cruise ship growth factors for Galveston and Harris County, so an alternate source of data for all other counties reporting cruise ship activity/emissions was needed.[1] Table A-3 in Appendix A lists the annual growth factors applied by year.

Because of the multiple steps involved in the development of dredging activity growth factors, the procedures used are described more fully in the section below. Actual growth factor values used for developing the final inventory are presented in Table A-3.

1. Dredging Growth Factors

Pechan developed growth factors from the last year of available historical emissions data developed by ERG. These are as follows:

[1] In-port emissions for specific vessel types such as cruise ships were not available in the final 2008 data files for Brazoria and Harris counties. As such, the ERG/Alliance cruise ship growth factors for these counties could not be used.

County	Base Year
Aransas	2006
Brazoria	2008
Calhoun	2008
Cameron	2008
Chambers	2005
Galveston	2008
Harris	2008
Jefferson	2008
Kenedy	2000
Kleberg	2003
Matagorda	2006
Nueces	2007
San Patricio	2006
Willacy	2000

The following summarizes the methods, data sources, and assumptions that Pechan used to develop a complete final set of dredging activity growth factors covering the years 1990-2040.[2] The discussion is first organized into the approach used for counties with pre-2007 base years. This is followed by a description of the approach used for counties with base years of 2007 or 2008. Each of these discussions is further organized into two or three subsections, which pertain to time-frames in which particular dredging activity data sets were available.

a. Counties with pre-2007 Base Years

1990-2006 Trend

Pechan calculated county-level growth factors to back-cast dredging emissions from the base year back through 1990 using the 1990-2006 number of dredging days in each county. These data were compiled by Eastern Research Group from U.S. Army Corps of Engineers (USACE) information (ERG/Alliance, 2007).

Post-2006 Trend

In previous work for the TCEQ, ERG developed growth factors representing post-2006 dredging activity based on repeating the county-level dredging days data for 1990-2006 (e.g., 2007 was assigned the same number of dredging days as 1990). For Harris County, for example, ERG estimated 113 and 1,262 dredging days in the county in 1992 and 2000, respectively. The 113 dredging day estimate from 1992 was used to estimate activity in 2009, and the 1,262 dredging day estimate was used to estimate activity in 2017. Because it is not clear that repeating the 1990-2006 data represents a reasonable approach to projecting post-2006 dredging activity, Pechan implemented a different approach as outlined below.

Pechan first compiled the Galveston District 2006-2009 number of actual cubic yards of material dredged from two USACE contracts databases (USACE, 2010b and USACE, 2010c). Next,

[2] The final methods differ from those used in developing the draft inventory. The major difference is the use of county-level dredging days data to back-cast emissions from the base year back through 1990 (the draft inventory was back-cast using Galveston District cubic yards of material dredged data).

Pechan developed growth factors reflecting the post-2006 trend in cubic yards dredged in the District (USACE, 2010b). Since 2010 has not yet ended, the total number of actual cubic yards dredged was not yet available from the Fiscal Year 2010 USACE contracts database (USACE, 2010d). However, Pechan compiled two values from the 2010 contracts database—the first was the total cubic yards dredged estimates for active and completed projects (19.8 million cubic yards), and the second was the total volume of material dredged for all projects in the database with estimated start and end dates completely or predominantly within 2010 (31.35 million cubic yards). Pechan used the approximate average of the two values to estimate the 2010 volume of material dredged (25 million cubic yards), and this value was used, along with the actual cubic yards data for 2006-2009, to calculate the 2010 growth factor applied to each applicable county. It is important to note that Pechan did not project post-2006 dredging activity for counties that did not have dredging activity for at least 50 percent of the years over both the 1990-2006 and the 2000-2006 time periods.

To assist in assigning reasonable growth factors for post-2010 activity, Pechan computed the average of the actual cubic yards of material dredged for the Galveston District for the 1990-2009 period. Because this value (24.8 million cubic yards) approximates the 2010 cubic yard estimate of 25 million yards, Pechan applied the 2010 growth factor to estimate dredging activity for all post-2010 years.

b. Counties with Base Years of 2007 or 2008

2006-2008 Trend

For counties with base years of 2007 or 2008, Pechan utilized three data sets to represent 2006-2008 dredging trends. The first set of data were 2007 and 2008 county-level emission estimates developed by ERG (ERG, 2009a; ERG, 2009b). These data reflect actual dredging activity estimates for each year. Note that this results in use of 2007/2008 growth factors of "0" for most counties because ERG's emissions inventory reports "0" emissions for most counties in both years.

Next, Pechan developed growth factors of "0" for 2006 for counties for which the aforementioned 1990-2006 county-level dredging days data set reports no dredging days in that year (ERG/Alliance, 2007).[3]

A third data set was used to develop non-zero growth factors for 2006. Because county-level dredging days data were not readily available for 2007-2008, 2006 growth factors for counties reporting dredging days in 2006 were developed using the trend in the actual number of cubic yards of material dredged for the Galveston District as reported in USACE's October 1, 1996 to September 30, 2009 contracts database (USACE, 2010b). In particular, Pechan used the district-level 2006-2007 trend to develop 2006 growth factors for counties with 2007 dredging emissions, and the district-level 2006-2008 trend to develop 2006 growth factors for counties without 2007 dredging emissions.

[3] Note that as described earlier, although ERG, 2007 only presents dredging activity data beginning in 1999 (see Table 2-39), the 2007-2015 data actually represent the number of dredging days in 1990-1998.

Pre-2006 Trend

Pechan calculated county-level growth factors relative to year 2006 using the 1990-2006 number of dredging days in each county as compiled by ERG (ERG/Alliance, 2007). For counties for which no dredging days were reported for 2006, Pechan developed 2005 growth factors based on the 2005 and 2007 number of cubic yards of material dredged for the Galveston District (USACE, 2010b). For these counties, all pre-2005 growth factors were computed using the dredging days in each county as compiled by ERG.

Post-2008 Trend

Pechan used the same post-2008 year growth factors computed as described in the "Counties with pre-2007 Base Years" section above to project dredging activity for counties with base years of 2007 or 2008.

C. CONTROLS

Base year emissions as compiled represented uncontrolled emissions (ERG, 2009a). Control factors for diesel-fueled vessels were developed based on information available from EPA's Regulatory Impact Analyses to support their recent Category 1 & 2 engine rulemaking (EPA, 2008). Estimated control factors were developed for Category 1 & 2 engines based on emission reductions calculated from national base case and control case inventories developed for the years 2002 through 2040. These control factors account for both the level of control required by the standard (i.e., control efficiency) as well as the measure of rule penetration (i.e., what fraction of the fleet is meeting the specific level of control).

Emission reductions and associated control factors for Category 3 engines (assumed to be residual-fueled) were based on Gulf Coast Region base case and control case inventories. EPA's RIA for Category 3 engines only included base and control case inventories for the years 2002, 2020, and 2030 (EPA, 2009). An estimate of the control effectiveness for each year is needed to accurately account for how the standards impact the entire fleet from one year to the next. As such, we obtained Gulf Coast regional inventories for all other interim years out to 2040 from EPA OTAQ (Carey, 2010).

Table II-4 provides the year-specific control factors for diesel-fueled or Category 1 & 2 engine SCCs (2280002100 and 2280002200). Table II-5 lists control factors by year for residual-fueled, or Category 3 SCCs (2280003100 and 2280003200). Emission reductions were modeled for all CMV categories for NO_X, SO_2, PM-10, and PM-2.5, as well as VOC for Category 1 & 2 engines. The control factors were applied to the estimated emissions for each year using the following equation:

$$EM_{controlled} = EM_{uncontrolled} * (1 - \text{Control Factor})$$

Uncontrolled emission inventories were also estimated for each year, in which case no controls were applied for the relevant calendar years.

Table II-4. Category 1 & 2 Engine CMV Control Factors

YEAR	PM-10	PM-2.5	NO_X	VOC	SO_2
2002	0.00	0.00	0.00	0.00	0.00
2003	0.00	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00	0.00
2008	0.01	0.01	0.01	0.00	0.00
2009	0.02	0.02	0.02	0.00	0.00
2010	0.03	0.03	0.03	0.00	0.00
2011	0.04	0.04	0.04	0.00	0.00
2012	0.06	0.06	0.05	0.01	0.00
2013	0.09	0.09	0.06	0.02	0.00
2014	0.12	0.12	0.09	0.05	0.00
2015	0.13	0.13	0.11	0.08	0.00
2016	0.16	0.16	0.13	0.12	0.02
2017	0.20	0.20	0.16	0.16	0.05
2018	0.23	0.23	0.20	0.21	0.07
2019	0.26	0.26	0.23	0.25	0.07
2020	0.29	0.29	0.26	0.29	0.05
2021	0.32	0.32	0.29	0.33	0.06
2022	0.36	0.36	0.33	0.37	0.08
2023	0.39	0.39	0.36	0.41	0.09
2024	0.42	0.42	0.39	0.45	0.10
2025	0.45	0.45	0.42	0.48	0.11
2026	0.48	0.48	0.45	0.51	0.12
2027	0.51	0.51	0.48	0.54	0.13
2028	0.53	0.53	0.50	0.57	0.14
2029	0.56	0.56	0.53	0.59	0.15
2030	0.58	0.58	0.55	0.61	0.16
2031	0.61	0.61	0.57	0.63	0.17
2032	0.63	0.63	0.59	0.64	0.18
2033	0.65	0.65	0.60	0.66	0.19
2034	0.67	0.67	0.62	0.67	0.20
2035	0.68	0.68	0.63	0.68	0.21
2036	0.70	0.70	0.65	0.69	0.22
2037	0.71	0.71	0.66	0.70	0.22
2038	0.73	0.73	0.66	0.71	0.23
2039	0.74	0.74	0.67	0.71	0.24
2040	0.74	0.74	0.68	0.71	0.24

Table II-5. Category 3 Engine CMV Control Factors

YEAR	NO_X	PM-10	PM-2.5	SO_2
2002	0.00	0.00	0.00	0.00
2003	0.03	0.00	0.01	0.00
2004	0.04	0.00	0.01	0.00
2005	0.04	0.00	0.01	0.00
2006	0.05	0.00	0.01	0.00
2007	0.06	0.00	0.01	0.00
2008	0.06	0.00	0.01	0.00
2009	0.07	0.00	0.01	0.00
2010	0.13	0.67	0.67	0.64
2011	0.14	0.67	0.67	0.64
2012	0.16	0.67	0.67	0.64
2013	0.17	0.67	0.67	0.64
2014	0.19	0.67	0.67	0.64
2015	0.20	0.86	0.87	0.96
2016	0.22	0.86	0.87	0.96
2017	0.27	0.86	0.87	0.96
2018	0.32	0.86	0.87	0.96
2019	0.37	0.86	0.87	0.96
2020	0.41	0.86	0.86	0.96
2021	0.45	0.86	0.87	0.96
2022	0.47	0.86	0.87	0.96
2023	0.52	0.86	0.87	0.96
2024	0.55	0.86	0.87	0.96
2025	0.58	0.86	0.87	0.96
2026	0.61	0.86	0.87	0.96
2027	0.63	0.86	0.87	0.96
2028	0.66	0.86	0.87	0.96
2029	0.67	0.86	0.87	0.96
2030	0.69	0.86	0.86	0.96
2031	0.70	0.86	0.87	0.96
2032	0.71	0.86	0.87	0.96
2033	0.72	0.86	0.87	0.96
2034	0.74	0.86	0.87	0.96
2035	0.75	0.86	0.87	0.96
2036	0.76	0.86	0.87	0.96
2037	0.77	0.86	0.87	0.96
2038	0.78	0.86	0.87	0.96
2039	0.79	0.86	0.87	0.96
2040	0.80	0.86	0.87	0.96

III. EMISSION SUMMARIES

Tables III-1 through III-4 present both uncontrolled and controlled annual and OSD statewide CMV emissions for all pollutants for the years 1990 through 2040. For the purposes of these summaries, emissions were summed for all four SCCs (i.e., diesel port and underway, and residual port and underway).

Uncontrolled emissions show variable increases and decreases throughout the 1990 to 2009 time frame. After 2009, emissions generally increase each year up to 2040 due to the forecasted growth in activity. For the controlled inventories, growth in activity is generally offset by reductions from emission standards impacting NO_X, VOC, PM-10 and PM-2.5, resulting in decreases in emissions over the 2010 to 2040 time frame. Significant reductions in SO_2 emissions are evident in the years 2010 and 2015, with a leveling off after that point in time. CO and NH_3 emissions show the same trend for controlled and uncontrolled inventories as no reductions were modeled by EPA for these pollutants.

Additional tables are also provided in Appendix B to display the annual and OSD emission trends for the HGB nonattainment area.

Table III-1. Texas Statewide Uncontrolled Annual CMV Emissions, tons per year

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	474.98	17,904.92	1,801.19	1,204.63	1,045.00	14,619.25	6.97
1991	560.36	22,552.54	2,234.22	1,320.81	1,153.49	15,756.72	8.28
1992	590.40	23,887.03	2,362.95	1,381.41	1,206.41	16,449.77	8.76
1993	552.11	21,115.55	2,115.75	1,373.74	1,191.05	16,593.31	8.16
1994	600.05	23,496.35	2,342.73	1,453.66	1,263.29	17,450.58	8.90
1995	564.78	20,905.62	2,112.21	1,449.05	1,250.99	17,621.06	8.33
1996	591.23	22,474.47	2,253.58	1,478.80	1,280.43	17,874.08	8.73
1997	663.46	25,386.92	2,546.33	1,638.64	1,417.14	19,755.73	9.85
1998	654.08	24,536.28	2,470.80	1,648.69	1,422.36	19,962.69	9.71
1999	854.13	37,353.29	3,628.44	1,801.99	1,589.37	20,858.87	12.69
2000	727.57	27,482.77	2,765.96	1,813.78	1,564.03	21,906.44	10.76
2001	717.67	27,026.66	2,717.93	1,798.15	1,550.43	21,735.94	10.60
2002	757.14	30,006.67	2,976.27	1,803.59	1,565.89	21,537.30	11.17
2003	819.09	32,615.92	3,235.72	1,935.54	1,679.96	23,080.96	12.17
2004	706.65	24,924.13	2,548.40	1,881.58	1,611.10	23,048.49	10.48
2005	676.17	22,344.85	2,322.10	1,898.11	1,614.76	23,498.53	9.91
2006	688.24	22,167.17	2,324.40	1,963.43	1,666.05	24,380.35	10.13
2007	659.54	20,960.18	2,198.87	1,909.25	1,620.01	23,768.03	9.77
2008	668.35	21,775.86	2,267.43	1,902.73	1,618.65	23,606.12	9.90
2009	760.96	26,041.48	2,679.18	2,076.09	1,770.44	25,549.41	11.18
2010	885.92	33,087.36	3,330.22	2,231.78	1,918.45	27,007.56	12.92
2011	902.31	33,570.63	3,383.13	2,279.73	1,958.71	27,600.56	13.16
2012	917.12	33,992.23	3,428.52	2,324.88	1,996.17	28,169.05	13.38
2013	934.01	34,484.55	3,484.53	2,372.99	2,036.59	28,759.13	13.62
2014	947.68	34,877.63	3,523.41	2,417.36	2,073.28	29,328.40	13.83
2015	962.98	35,314.93	3,571.20	2,463.19	2,111.43	29,900.73	14.06
2016	978.38	35,766.88	3,618.98	2,509.92	2,150.47	30,486.55	14.29
2017	992.81	36,177.46	3,662.31	2,554.65	2,187.52	31,052.67	14.51
2018	1,008.72	36,640.89	3,712.98	2,601.70	2,226.88	31,637.31	14.74
2019	1,024.23	37,094.44	3,761.69	2,648.44	2,265.94	32,224.36	14.97
2020	1,040.67	37,570.10	3,815.38	2,695.74	2,305.55	32,806.76	15.21
2021	1,055.80	38,006.98	3,862.09	2,741.66	2,343.79	33,382.80	15.44
2022	1,070.94	38,443.84	3,908.80	2,787.58	2,382.02	33,958.82	15.66
2023	1,086.07	38,880.70	3,955.51	2,833.49	2,420.25	34,534.84	15.89
2024	1,101.21	39,317.56	4,002.22	2,879.41	2,458.48	35,110.86	16.11
2025	1,116.34	39,754.42	4,048.94	2,925.33	2,496.71	35,686.88	16.34
2026	1,131.48	40,191.28	4,095.65	2,971.24	2,534.95	36,262.90	16.57
2027	1,146.61	40,628.14	4,142.36	3,017.16	2,573.18	36,838.93	16.79
2028	1,161.74	41,065.00	4,189.07	3,063.08	2,611.41	37,414.95	17.02
2029	1,176.88	41,501.86	4,235.79	3,109.00	2,649.64	37,990.97	17.24
2030	1,192.01	41,938.72	4,282.50	3,154.91	2,687.87	38,566.99	17.47
2031	1,207.15	42,375.58	4,329.21	3,200.83	2,726.10	39,143.01	17.69
2032	1,222.28	42,812.44	4,375.92	3,246.75	2,764.33	39,719.03	17.92
2033	1,237.42	43,249.30	4,422.63	3,292.66	2,802.57	40,295.05	18.15
2034	1,252.55	43,686.16	4,469.35	3,338.58	2,840.80	40,871.08	18.37
2035	1,267.68	44,123.00	4,516.06	3,384.50	2,879.03	41,447.09	18.60
2036	1,282.91	44,563.07	4,563.27	3,430.55	2,917.40	42,024.28	18.82
2037	1,298.14	45,003.12	4,610.48	3,476.60	2,955.76	42,601.47	19.05
2038	1,313.37	45,443.17	4,657.69	3,522.65	2,994.12	43,178.65	19.28
2039	1,328.59	45,883.23	4,704.90	3,568.70	3,032.49	43,755.83	19.50
2040	1,343.82	46,323.26	4,752.11	3,614.75	3,070.85	44,333.01	19.73

Table III-2. Texas Statewide Controlled Annual CMV Emissions, tons per year

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	474.98	17,904.92	1,801.19	1,204.63	1,045.00	14,619.25	6.97
1991	560.36	22,552.54	2,234.22	1,320.81	1,153.49	15,756.72	8.28
1992	590.40	23,887.03	2,362.95	1,381.41	1,206.41	16,449.77	8.76
1993	552.11	21,115.55	2,115.75	1,373.74	1,191.05	16,593.31	8.16
1994	600.05	23,496.35	2,342.73	1,453.66	1,263.29	17,450.58	8.90
1995	564.78	20,905.62	2,112.21	1,449.05	1,250.99	17,621.06	8.33
1996	591.23	22,474.47	2,253.58	1,478.80	1,280.43	17,874.08	8.73
1997	663.46	25,386.92	2,546.33	1,638.64	1,417.14	19,755.73	9.85
1998	654.08	24,536.28	2,470.80	1,648.69	1,422.36	19,962.69	9.71
1999	854.13	37,353.29	3,628.44	1,801.99	1,589.37	20,858.87	12.69
2000	727.57	27,482.77	2,765.96	1,813.78	1,564.03	21,906.44	10.76
2001	717.67	27,026.66	2,717.93	1,798.15	1,550.43	21,735.94	10.60
2002	757.14	30,006.67	2,976.27	1,803.59	1,565.89	21,537.30	11.17
2003	819.09	32,147.61	3,235.72	1,929.39	1,671.83	23,002.39	12.17
2004	706.65	24,334.20	2,548.40	1,875.11	1,602.57	22,965.79	10.48
2005	676.17	21,636.29	2,322.10	1,891.37	1,605.87	23,412.28	9.91
2006	688.24	21,355.13	2,324.40	1,956.39	1,656.78	24,290.23	10.13
2007	659.54	20,028.24	2,198.87	1,902.35	1,610.91	23,679.81	9.77
2008	668.35	20,689.53	2,267.43	1,893.99	1,607.76	23,519.04	9.90
2009	760.96	24,687.01	2,679.18	2,063.76	1,755.86	25,456.49	11.18
2010	885.92	30,393.93	3,330.22	971.70	860.69	11,314.33	12.92
2011	902.31	30,484.23	3,383.13	986.23	872.54	11,535.47	13.16
2012	913.91	30,371.49	3,428.52	995.26	878.92	11,741.97	13.38
2013	927.52	30,329.40	3,484.53	1,002.51	883.56	11,963.05	13.62
2014	931.41	29,885.77	3,523.41	1,006.62	885.07	12,167.83	13.83
2015	936.76	29,678.56	3,571.20	614.95	561.96	3,636.16	14.06
2016	938.79	29,300.05	3,618.98	611.83	557.79	3,612.53	14.29
2017	939.76	28,191.39	3,662.31	604.02	548.97	3,556.83	14.51
2018	938.50	26,814.61	3,712.98	601.06	544.98	3,536.31	14.74
2019	940.04	25,656.49	3,761.69	597.70	540.58	3,570.58	14.97
2020	942.03	24,657.94	3,815.38	594.54	539.13	3,657.22	15.21
2021	942.85	23,634.14	3,862.09	590.38	531.22	3,657.00	15.44
2022	943.51	22,601.68	3,908.80	582.01	521.87	3,629.28	15.66
2023	944.00	21,353.93	3,955.51	577.46	516.31	3,628.70	15.89
2024	944.33	20,281.50	4,002.22	572.76	510.60	3,627.97	16.11
2025	947.98	19,309.17	4,048.94	567.90	504.74	3,627.11	16.34
2026	951.52	18,366.23	4,095.65	562.89	498.72	3,626.10	16.57
2027	954.92	17,529.75	4,142.36	557.71	492.55	3,624.95	16.79
2028	958.20	16,805.08	4,189.07	556.55	490.36	3,623.65	17.02
2029	964.94	16,009.73	4,235.79	551.10	483.92	3,622.22	17.24
2030	971.60	15,375.53	4,282.50	549.77	484.78	3,620.80	17.47
2031	978.17	14,890.26	4,329.21	543.95	474.77	3,618.91	17.69
2032	988.32	14,399.32	4,375.92	542.32	472.12	3,617.05	17.92
2033	994.74	14,087.64	4,422.63	540.59	469.37	3,615.04	18.15
2034	1,004.78	13,531.14	4,469.35	538.75	466.51	3,612.90	18.37
2035	1,014.78	13,185.48	4,516.06	541.16	467.86	3,610.60	18.60
2036	1,024.77	12,627.95	4,563.27	539.18	464.87	3,608.98	18.82
2037	1,034.71	12,156.51	4,610.48	541.49	466.12	3,635.64	19.05
2038	1,044.60	11,990.13	4,657.69	539.32	462.94	3,633.77	19.28
2039	1,058.27	11,738.87	4,704.90	541.50	464.07	3,631.74	19.50
2040	1,071.93	11,497.35	4,752.11	548.11	469.57	3,658.22	19.73

Table III-3. Texas Statewide Uncontrolled OSD CMV Emissions, tons per day

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	1.30	49.05	4.93	3.30	2.86	40.05	0.02
1991	1.54	61.79	6.12	3.62	3.16	43.17	0.02
1992	1.62	65.44	6.47	3.78	3.31	45.07	0.02
1993	1.51	57.85	5.80	3.76	3.26	45.46	0.02
1994	1.64	64.37	6.42	3.98	3.46	47.81	0.02
1995	1.55	57.28	5.79	3.97	3.43	48.28	0.02
1996	1.62	61.57	6.17	4.05	3.51	48.97	0.02
1997	1.82	69.55	6.98	4.49	3.88	54.13	0.03
1998	1.79	67.22	6.77	4.52	3.90	54.69	0.03
1999	2.34	102.34	9.94	4.94	4.35	57.15	0.03
2000	1.99	75.30	7.58	4.97	4.29	60.02	0.03
2001	1.97	74.05	7.45	4.93	4.25	59.55	0.03
2002	2.07	82.21	8.15	4.94	4.29	59.01	0.03
2003	2.24	89.36	8.86	5.30	4.60	63.24	0.03
2004	1.94	68.29	6.98	5.16	4.41	63.15	0.03
2005	1.85	61.22	6.36	5.20	4.42	64.38	0.03
2006	1.89	60.73	6.37	5.38	4.56	66.80	0.03
2007	1.81	57.43	6.02	5.23	4.44	65.12	0.03
2008	1.83	59.66	6.21	5.21	4.43	64.67	0.03
2009	2.08	71.35	7.34	5.69	4.85	70.00	0.03
2010	2.43	90.65	9.12	6.11	5.26	73.99	0.04
2011	2.47	91.97	9.27	6.25	5.37	75.62	0.04
2012	2.51	93.13	9.39	6.37	5.47	77.18	0.04
2013	2.56	94.48	9.55	6.50	5.58	78.79	0.04
2014	2.60	95.56	9.65	6.62	5.68	80.35	0.04
2015	2.64	96.75	9.78	6.75	5.78	81.92	0.04
2016	2.68	97.99	9.92	6.88	5.89	83.52	0.04
2017	2.72	99.12	10.03	7.00	5.99	85.08	0.04
2018	2.76	100.39	10.17	7.13	6.10	86.68	0.04
2019	2.81	101.63	10.31	7.26	6.21	88.29	0.04
2020	2.85	102.93	10.45	7.39	6.32	89.88	0.04
2021	2.89	104.13	10.58	7.51	6.42	91.46	0.04
2022	2.93	105.33	10.71	7.64	6.53	93.04	0.04
2023	2.98	106.52	10.84	7.76	6.63	94.62	0.04
2024	3.02	107.72	10.96	7.89	6.74	96.19	0.04
2025	3.06	108.92	11.09	8.01	6.84	97.77	0.04
2026	3.10	110.11	11.22	8.14	6.95	99.35	0.05
2027	3.14	111.31	11.35	8.27	7.05	100.93	0.05
2028	3.18	112.51	11.48	8.39	7.15	102.51	0.05
2029	3.22	113.70	11.60	8.52	7.26	104.08	0.05
2030	3.27	114.90	11.73	8.64	7.36	105.66	0.05
2031	3.31	116.10	11.86	8.77	7.47	107.24	0.05
2032	3.35	117.29	11.99	8.90	7.57	108.82	0.05
2033	3.39	118.49	12.12	9.02	7.68	110.40	0.05
2034	3.43	119.69	12.24	9.15	7.78	111.98	0.05
2035	3.47	120.88	12.37	9.27	7.89	113.55	0.05
2036	3.51	122.09	12.50	9.40	7.99	115.14	0.05
2037	3.56	123.30	12.63	9.52	8.10	116.72	0.05
2038	3.60	124.50	12.76	9.65	8.20	118.30	0.05
2039	3.64	125.71	12.89	9.78	8.31	119.88	0.05
2040	3.68	126.91	13.02	9.90	8.41	121.46	0.05

Table III-4. Texas Statewide Controlled OSD CMV Emissions, tons per day

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	1.30	49.05	4.93	3.30	2.86	40.05	0.02
1991	1.54	61.79	6.12	3.62	3.16	43.17	0.02
1992	1.62	65.44	6.47	3.78	3.31	45.07	0.02
1993	1.51	57.85	5.80	3.76	3.26	45.46	0.02
1994	1.64	64.37	6.42	3.98	3.46	47.81	0.02
1995	1.55	57.28	5.79	3.97	3.43	48.28	0.02
1996	1.62	61.57	6.17	4.05	3.51	48.97	0.02
1997	1.82	69.55	6.98	4.49	3.88	54.13	0.03
1998	1.79	67.22	6.77	4.52	3.90	54.69	0.03
1999	2.34	102.34	9.94	4.94	4.35	57.15	0.03
2000	1.99	75.30	7.58	4.97	4.29	60.02	0.03
2001	1.97	74.05	7.45	4.93	4.25	59.55	0.03
2002	2.07	82.21	8.15	4.94	4.29	59.01	0.03
2003	2.24	88.08	8.86	5.29	4.58	63.02	0.03
2004	1.94	66.67	6.98	5.14	4.39	62.92	0.03
2005	1.85	59.28	6.36	5.18	4.40	64.14	0.03
2006	1.89	58.51	6.37	5.36	4.54	66.55	0.03
2007	1.81	54.87	6.02	5.21	4.41	64.88	0.03
2008	1.83	56.68	6.21	5.19	4.40	64.44	0.03
2009	2.08	67.64	7.34	5.65	4.81	69.74	0.03
2010	2.43	83.27	9.12	2.66	2.36	31.00	0.04
2011	2.47	83.52	9.27	2.70	2.39	31.60	0.04
2012	2.50	83.21	9.39	2.73	2.41	32.17	0.04
2013	2.54	83.09	9.55	2.75	2.42	32.78	0.04
2014	2.55	81.88	9.65	2.76	2.42	33.34	0.04
2015	2.57	81.31	9.78	1.68	1.54	9.96	0.04
2016	2.57	80.27	9.92	1.68	1.53	9.90	0.04
2017	2.57	77.24	10.03	1.65	1.50	9.74	0.04
2018	2.57	73.46	10.17	1.65	1.49	9.69	0.04
2019	2.58	70.29	10.31	1.64	1.48	9.78	0.04
2020	2.58	67.56	10.45	1.63	1.48	10.02	0.04
2021	2.58	64.75	10.58	1.62	1.46	10.02	0.04
2022	2.58	61.92	10.71	1.59	1.43	9.94	0.04
2023	2.59	58.50	10.84	1.58	1.41	9.94	0.04
2024	2.59	55.57	10.96	1.57	1.40	9.94	0.04
2025	2.60	52.90	11.09	1.56	1.38	9.94	0.04
2026	2.61	50.32	11.22	1.54	1.37	9.93	0.05
2027	2.62	48.03	11.35	1.53	1.35	9.93	0.05
2028	2.63	46.04	11.48	1.52	1.34	9.93	0.05
2029	2.64	43.86	11.60	1.51	1.33	9.92	0.05
2030	2.66	42.12	11.73	1.51	1.33	9.92	0.05
2031	2.68	40.80	11.86	1.49	1.30	9.91	0.05
2032	2.71	39.45	11.99	1.49	1.29	9.91	0.05
2033	2.73	38.60	12.12	1.48	1.29	9.90	0.05
2034	2.75	37.07	12.24	1.48	1.28	9.90	0.05
2035	2.78	36.12	12.37	1.48	1.28	9.89	0.05
2036	2.81	34.60	12.50	1.48	1.27	9.89	0.05
2037	2.83	33.31	12.63	1.48	1.28	9.96	0.05
2038	2.86	32.85	12.76	1.48	1.27	9.96	0.05
2039	2.90	32.16	12.89	1.48	1.27	9.95	0.05
2040	2.94	31.50	13.02	1.50	1.29	10.02	0.05

IV. QUALITY ASSURANCE PROCEDURES

Pechan prepared a quality assurance project plan (QAPP) for the project to ensure that calculations and data analysis were performed in accordance with well-defined procedures, and were reliable and complete. The final deliverable for this task was controlled and uncontrolled emission estimates and activity data for 50 separate calendar years (1990-2040), for two time periods (annual and summer season weekday), and 15 Texas counties. As such, it was important to carefully review both the data and equations used in the emission estimation calculations.

Pechan first reviewed available base year emission estimates from several reports and databases that would be needed to prepare a complete base year commercial marine inventory. Pechan cross-checked summations of specific vessel-type emission estimates reported in databases provided by the TCEQ with reported CMV emission totals in available reports. Pechan was able to replicate emission estimates compiled for the Port of Houston and grown to 2008, as well as 2007 emission estimates developed for the Texas State Waters Inventory.

Surrogate data for developing growth factors were identified and compiled and used to calculate year-specific growth factors. Growth factor values were reviewed for reasonableness and accuracy. Any abnormally high or low growth factors were flagged for review. The growth factors were compiled into a database according to year, county, and SCC.

Pechan also compiled control factors values into a database that represented the overall control levels estimated by EPA by pollutant, year and CMV engine type. Both the growth factor and the control factor table, as well as the corresponding algorithms used for generating controlled and uncontrolled annual and seasonal emission estimates were reviewed by the Pechan Project Manager.

After QA review of the growth and control data, year-specific emission estimates were developed using the established algorithms. Calculations were verified by manually replicating the results obtained for an example data record. The annual and OSD emission estimates for all pollutants and all years, as well as activity data, were reviewed to ensure that the results are showing the expected trend, given the applied growth and control factor values.

As a final step, Pechan converted the emissions and activity data into NIF 3.0 text formatted files for submittal to the TCEQ. For county records where the activity data (HP-HR) were missing, an average ratio of activity to emissions was developed at the SCC and pollutant level based on those records/counties reporting activity data. The ratios were then applied to the county emissions to estimate the missing activity (since TexAER requires the throughput field to be populated). Pechan performed spot-checks of the results prior to conversion with the final NIF 3.0 files to ensure that the data were accurately transferred for all populated fields. Pechan also ran EPA's NIF QA Checker program on the NIF files, to identify any referential integrity issues and invalid codes. The NIF files passed this program check and were submitted to the TCEQ. However, the TCEQ identified some additional corrections needed related to throughput units for the files to pass through the Texas Air Emissions Repository (TexAER). Pechan implemented these changes and provided updated files to the TCEQ, which subsequently were accepted into TexAER.

V. REFERENCES

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APPENDIX A. GROWTH FACTORS FOR SELECT CMV TYPES

Table A-1. Line Haul Tugboat Growth Factors by Segment and Year (Relative to 2007)

Year	Segment	Growth Factor	Segment	Growth Factor	Segment	Growth Factor
1990	1	0.969	2	0.879	3	0.866
1991	1	0.971	2	0.886	3	0.874
1992	1	1.019	2	0.844	3	0.898
1993	1	0.977	2	0.875	3	0.942
1994	1	1.002	2	0.926	3	0.936
1995	1	1.007	2	0.927	3	0.843
1996	1	0.967	2	0.911	3	0.883
1997	1	0.970	2	0.992	3	0.945
1998	1	0.918	2	0.983	3	0.930
1999	1	0.919	2	0.949	3	0.897
2000	1	0.990	2	0.974	3	0.849
2001	1	0.953	2	0.935	3	1.025
2002	1	0.946	2	0.880	3	0.908
2003	1	1.013	2	0.985	3	0.918
2004	1	1.082	2	1.007	3	1.083
2005	1	1.020	2	0.964	3	1.003
2006	1	0.998	2	0.993	3	0.992
2007	1	1.000	2	1.000	3	1.000
2008	1	1.010	2	1.010	3	1.019
2009	1	1.020	2	1.010	3	1.048
2010	1	1.029	2	1.020	3	1.067
2011	1	1.039	2	1.030	3	1.087
2012	1	1.049	2	1.030	3	1.106
2013	1	1.059	2	1.040	3	1.125
2014	1	1.069	2	1.050	3	1.144
2015	1	1.078	2	1.050	3	1.163
2016	1	1.088	2	1.059	3	1.192
2017	1	1.098	2	1.059	3	1.212
2018	1	1.108	2	1.069	3	1.231
2019	1	1.127	2	1.079	3	1.250
2020	1	1.137	2	1.079	3	1.269
2021	1	1.140	2	1.086	3	1.289
2022	1	1.142	2	1.094	3	1.299
2023	1	1.145	2	1.101	3	1.309
2024	1	1.147	2	1.108	3	1.319
2025	1	1.150	2	1.116	3	1.329
2026	1	1.152	2	1.123	3	1.339
2027	1	1.155	2	1.130	3	1.349
2028	1	1.157	2	1.137	3	1.358
2029	1	1.160	2	1.145	3	1.368
2030	1	1.162	2	1.152	3	1.378
2031	1	1.165	2	1.159	3	1.388
2032	1	1.168	2	1.166	3	1.398
2033	1	1.170	2	1.174	3	1.408
2034	1	1.173	2	1.181	3	1.418
2035	1	1.175	2	1.188	3	1.418
2036	1	1.180	2	1.195	3	1.442
2037	1	1.185	2	1.202	3	1.455
2038	1	1.191	2	1.209	3	1.468
2039	1	1.196	2	1.216	3	1.481
2040	1	1.201	2	1.222	3	1.483

Table A-2. Port of Houston Growth Factors by Year (Relative to 2008)

Year	Growth Factor
1990	0.562
1991	0.589
1992	0.616
1993	0.643
1994	0.670
1995	0.697
1996	0.698
1997	0.780
1998	0.797
1999	0.748
2000	0.879
2001	0.872
2002	0.837
2003	0.900
2004	0.952
2005	0.997
2006	1.047
2007	1.018
2008	1.000
2009	1.076
2010	1.103
2011	1.130
2012	1.157
2013	1.184
2014	1.211
2015	1.238
2016	1.265
2017	1.292
2018	1.319
2019	1.346
2020	1.374
2021	1.401
2022	1.428
2023	1.455
2024	1.482
2025	1.509
2026	1.536
2027	1.563
2028	1.590
2029	1.617
2030	1.644
2031	1.671
2032	1.698
2033	1.725
2034	1.752
2035	1.779
2036	1.806
2037	1.833
2038	1.860
2039	1.888
2040	1.915

Table A-3. Cruise Ship Growth Factors by Year (Relative to 2007)

Year	Growth Factor
1990	0.303
1991	0.344
1992	0.385
1993	0.426
1994	0.467
1995	0.508
1996	0.549
1997	0.590
1998	0.631
1999	0.672
2000	0.713
2001	0.754
2002	0.795
2003	0.836
2004	0.877
2005	0.918
2006	0.959
2007	1.000
2008	1.041
2009	1.082
2010	1.123
2011	1.164
2012	1.205
2013	1.246
2014	1.287
2015	1.328
2016	1.369
2017	1.410
2018	1.451
2019	1.492
2020	1.533
2021	1.574
2022	1.615
2023	1.656
2024	1.697
2025	1.738
2026	1.779
2027	1.820
2028	1.861
2029	1.902
2030	1.943
2031	1.984
2032	2.025
2033	2.066
2034	2.107
2035	2.148
2036	2.189
2037	2.230
2038	2.271
2039	2.312
2040	2.353

Table A-4. Dredging Growth Factors by County and Year

FIPS	CNTYNAME	SCC	Base Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
48007	Aransas	2280002206	2006	0.383	0	0.438	0	0.938	0.932	0.228	0	0.938	0.549	0.944	0	0.895	0	0	0	1
48039	Brazoria	2280002206	2008	6.182	8.004	6.101	3.275	4.872	5.179	2.252	5.875	4.79	8.926	1.453	2.784	8.639	6.367	3.173	1.658	1.085
48057	Calhoun	2280002206	2008	0.398	3.662	0.696	1.881	3.156	0.642	5.163	2.496	5.127	4.43	2.667	5.326	5.298	4.114	0.543	0.895	1.085
48061	Cameron	2280002206	2008	0.132	0.132	0.452	0.359	0.764	0.183	0.067	0.272	0.229	0.039	0.243	0.286	0.176	0	0.127	0.308	0
48071	Chambers	2280002206	2005	2.575	1.425	0.463	1.338	3.188	3.8	0	1.15	1.913	1.625	1.988	2.325	3.663	10.763	2.788	1	0
48167	Galveston	2280002206	2008	2.907	2.076	4.402	2.292	2.757	2.957	2.973	7.292	6.312	18.32	7.823	3.937	0	5.199	2.608	1.362	0
48201	Harris	2280002206	2008	0.825	1.108	0.652	1.379	1.951	2.412	0.768	1.35	1.466	4.605	7.283	5.471	5.223	5.956	3.186	1.362	0
48245	Jefferson	2280002206	2008	1.675	8.388	7.678	6.67	6.841	1.504	6.912	4.456	1.604	9.637	3.534	4.357	12.13	9.48	3.207	0.114	0.738
48261	Kennedy	2280002206	2000	0	0	0.254	0	0	0	0	0	0	0	1	0	0	0	0	0	0
48273	Kleberg	2280002206	2003	0	0	0	0	0	0	0	0	0	0	0	0	0.624	1	0	0	0
48321	Matagorda	2280002206	2006	0	0.183	3.983	1.175	1.317	0.708	0.571	0.467	1.463	3.629	0.754	3.108	0.721	2.025	1.204	0.675	1
48355	Nueces	2280002206	2007	0	0.49	0.244	0	0.519	0.342	0	0	0.447	0.917	0	0.612	0	0.888	1.059	0.676	0
48409	San Patricio	2280002206	2006	1.055	0.621	0	0.469	0	0.738	0.648	0	0	0.262	0.607	0.855	1.241	0	0	1.89	1
48489	Willacy	2280002206	2000	0	0	0	0	0.866	1.159	0	1.146	0	0.476	1	0	0	0	0	0	0

FIPS	CNTYNAME	SCC	Base Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
48007	Aransas	2280002206	2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48039	Brazoria	2280002206	2008	0	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48057	Calhoun	2280002206	2008	0	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48061	Cameron	2280002206	2008	0.456	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48071	Chambers	2280002206	2005	0	0	1.419	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27
48167	Galveston	2280002206	2008	0	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48201	Harris	2280002206	2008	0	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48245	Jefferson	2280002206	2008	1.371	1	1.933	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48261	Kenedy	2280002206	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48273	Kleberg	2280002206	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48321	Matagorda	2280002206	2006	0	0	1.782	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106
48355	Nueces	2280002206	2007	1	0	0.959	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
48409	San Patricio	2280002206	2006	0	0	1.782	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106
48489	Willacy	2280002206	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIPS	CNTYNAME	SCC	Base Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
48007	Aransas	2280002206	2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48039	Brazoria	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48057	Calhoun	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48061	Cameron	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48071	Chambers	2280002206	2005	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27
48167	Galveston	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48201	Harris	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48245	Jefferson	2280002206	2008	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454	4.454
48261	Kenedy	2280002206	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48273	Kleberg	2280002206	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48321	Matagorda	2280002206	2006	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106
48355	Nueces	2280002206	2007	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
48409	San Patricio	2280002206	2006	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106	4.106
48489	Willacy	2280002206	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX B. ANNUAL AND OSD CMV EMISSION ESTIMATES FOR HOUSTON-GALVESTON-BRAZORIA NONATTAINMENT AREA

Table B-1. HGB Uncontrolled Annual CMV Emissions, tons per year

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	347.97	11,400.34	1,202.21	931.53	771.90	11,490.19	5.22
1991	362.09	11,790.32	1,245.96	973.41	806.09	12,017.61	5.43
1992	381.76	12,513.18	1,320.32	1,020.77	845.77	12,588.45	5.72
1993	366.58	11,145.42	1,202.90	1,033.39	850.70	12,881.95	5.50
1994	398.62	12,610.75	1,345.14	1,093.26	902.88	13,553.70	5.98
1995	418.38	13,338.90	1,419.90	1,140.76	942.71	14,126.09	6.27
1996	389.07	11,562.37	1,257.16	1,112.74	914.37	13,910.70	5.83
1997	490.29	16,259.13	1,712.18	1,297.19	1,075.69	15,963.20	7.35
1998	486.58	15,748.87	1,670.38	1,311.00	1,084.67	16,195.10	7.30
1999	601.02	23,432.19	2,359.73	1,376.43	1,163.81	16,378.46	9.01
2000	545.16	17,869.69	1,889.46	1,453.98	1,204.22	17,923.92	8.17
2001	508.62	15,798.43	1,697.24	1,410.28	1,162.56	17,524.68	7.63
2002	489.84	15,268.87	1,637.81	1,355.62	1,117.93	16,838.48	7.34
2003	572.66	19,173.97	2,014.56	1,502.95	1,247.36	18,464.11	8.59
2004	530.66	15,767.63	1,718.02	1,514.59	1,244.12	18,929.13	7.96
2005	523.01	14,541.56	1,619.33	1,553.22	1,269.87	19,559.07	7.84
2006	524.84	13,816.33	1,567.65	1,605.59	1,308.21	20,328.38	7.87
2007	505.33	13,131.69	1,495.83	1,557.12	1,267.88	19,739.50	7.58
2008	514.42	13,984.63	1,568.19	1,547.90	1,263.82	19,538.64	7.71
2009	571.21	16,107.48	1,785.81	1,682.18	1,376.53	21,150.26	8.56
2010	633.48	19,386.57	2,094.39	1,772.22	1,458.88	22,062.94	9.50
2011	646.78	19,727.51	2,133.60	1,813.32	1,492.30	22,584.33	9.70
2012	660.04	20,066.11	2,172.67	1,854.32	1,525.61	23,104.53	9.90
2013	673.34	20,406.98	2,211.88	1,895.41	1,559.02	23,625.88	10.10
2014	686.62	20,746.23	2,250.99	1,936.44	1,592.36	24,146.42	10.29
2015	699.86	21,083.20	2,289.98	1,977.37	1,625.61	24,665.78	10.49
2016	713.16	21,424.19	2,329.19	2,018.47	1,659.02	25,187.19	10.69
2017	726.42	21,762.75	2,368.26	2,059.47	1,692.33	25,707.37	10.89
2018	739.72	22,103.58	2,407.46	2,100.56	1,725.74	26,228.71	11.09
2019	753.00	22,443.21	2,446.60	2,141.60	1,759.10	26,749.43	11.29
2020	766.29	22,783.44	2,485.76	2,182.67	1,792.48	27,270.46	11.49
2021	779.57	23,122.88	2,524.89	2,223.71	1,825.83	27,791.08	11.69
2022	792.85	23,462.31	2,564.01	2,264.74	1,859.18	28,311.71	11.89
2023	806.13	23,801.75	2,603.13	2,305.78	1,892.53	28,832.33	12.09
2024	819.40	24,141.19	2,642.26	2,346.81	1,925.88	29,352.96	12.29
2025	832.68	24,480.62	2,681.38	2,387.84	1,959.23	29,873.58	12.48
2026	845.96	24,820.06	2,720.50	2,428.88	1,992.58	30,394.20	12.68
2027	859.24	25,159.50	2,759.63	2,469.91	2,025.93	30,914.83	12.88
2028	872.51	25,498.93	2,798.75	2,510.95	2,059.28	31,435.45	13.08
2029	885.79	25,838.37	2,837.87	2,551.98	2,092.63	31,956.08	13.28
2030	899.07	26,177.81	2,877.00	2,593.02	2,125.98	32,476.70	13.48
2031	912.35	26,517.24	2,916.12	2,634.05	2,159.33	32,997.33	13.68
2032	925.63	26,856.68	2,955.24	2,675.09	2,192.68	33,517.95	13.88
2033	938.90	27,196.11	2,994.37	2,716.12	2,226.02	34,038.57	14.08
2034	952.18	27,535.55	3,033.49	2,757.16	2,259.37	34,559.20	14.28
2035	965.46	27,874.99	3,072.61	2,798.19	2,292.72	35,079.82	14.48
2036	978.74	28,214.49	3,111.74	2,839.23	2,326.08	35,600.48	14.67
2037	992.02	28,553.99	3,150.87	2,880.27	2,359.43	36,121.14	14.87
2038	1,005.30	28,893.49	3,189.99	2,921.30	2,392.78	36,641.79	15.07
2039	1,018.57	29,233.00	3,229.12	2,962.34	2,426.13	37,162.45	15.27
2040	1,031.85	29,572.50	3,268.25	3,003.38	2,459.48	37,683.11	15.47

Table B-2. HGB Controlled Annual CMV Emissions, tons per year

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	347.97	11,400.34	1,202.21	931.53	771.90	11,490.19	5.22
1991	362.09	11,790.32	1,245.96	973.41	806.09	12,017.61	5.43
1992	381.76	12,513.18	1,320.32	1,020.77	845.77	12,588.45	5.72
1993	366.58	11,145.42	1,202.90	1,033.39	850.70	12,881.95	5.50
1994	398.62	12,610.75	1,345.14	1,093.26	902.88	13,553.70	5.98
1995	418.38	13,338.90	1,419.90	1,140.76	942.71	14,126.09	6.27
1996	389.07	11,562.37	1,257.16	1,112.74	914.37	13,910.70	5.83
1997	490.29	16,259.13	1,712.18	1,297.19	1,075.69	15,963.20	7.35
1998	486.58	15,748.87	1,670.38	1,311.00	1,084.67	16,195.10	7.30
1999	601.02	23,432.19	2,359.73	1,376.43	1,163.81	16,378.46	9.01
2000	545.16	17,869.69	1,889.46	1,453.98	1,204.22	17,923.92	8.17
2001	508.62	15,798.43	1,697.24	1,410.28	1,162.56	17,524.68	7.63
2002	489.84	15,268.87	1,637.81	1,355.62	1,117.93	16,838.48	7.34
2003	572.66	18,865.93	2,014.56	1,497.77	1,240.78	18,396.46	8.59
2004	530.66	15,375.08	1,718.02	1,509.12	1,237.15	18,857.57	7.96
2005	523.01	14,065.52	1,619.33	1,547.49	1,262.58	19,484.13	7.84
2006	524.84	13,265.24	1,567.65	1,599.58	1,300.56	20,249.76	7.87
2007	505.33	12,508.54	1,495.83	1,551.27	1,260.44	19,663.00	7.58
2008	514.42	13,270.21	1,568.19	1,541.10	1,255.48	19,463.46	7.71
2009	571.21	15,224.08	1,785.81	1,673.38	1,366.11	21,069.44	8.56
2010	633.48	17,656.34	2,094.39	702.54	592.50	8,397.23	9.50
2011	646.78	17,759.01	2,133.60	715.73	603.02	8,584.72	9.70
2012	658.31	17,759.36	2,172.67	726.96	611.62	8,771.60	9.90
2013	669.83	17,764.55	2,211.88	736.25	618.31	8,959.07	10.10
2014	677.74	17,616.50	2,250.99	745.38	624.85	9,146.26	10.29
2015	685.49	17,567.69	2,289.98	411.75	359.18	1,685.68	10.49
2016	691.37	17,396.27	2,329.19	413.13	359.53	1,689.86	10.69
2017	697.05	16,773.76	2,368.26	412.37	357.76	1,685.24	10.89
2018	700.75	15,967.00	2,407.46	413.46	357.82	1,689.21	11.09
2019	706.11	15,282.00	2,446.60	414.40	357.74	1,709.99	11.29
2020	711.33	14,693.28	2,485.76	415.16	359.75	1,747.48	11.49
2021	716.37	14,104.38	2,524.89	415.87	357.17	1,759.68	11.69
2022	721.25	13,538.08	2,564.01	414.30	354.63	1,763.33	11.89
2023	725.98	12,789.09	2,603.13	414.67	353.99	1,775.43	12.09
2024	730.54	12,158.83	2,642.26	414.91	353.23	1,787.48	12.29
2025	736.95	11,595.69	2,681.38	415.00	352.33	1,799.49	12.48
2026	743.23	11,050.88	2,720.50	414.97	351.30	1,811.45	12.68
2027	749.39	10,578.23	2,759.63	414.79	350.14	1,823.36	12.88
2028	755.44	10,150.47	2,798.75	416.72	351.04	1,835.22	13.08
2029	763.44	9,703.22	2,837.87	416.30	349.64	1,847.04	13.28
2030	771.36	9,335.68	2,877.00	418.08	353.09	1,858.95	13.48
2031	779.20	9,071.12	2,916.12	417.35	348.69	1,870.53	13.68
2032	789.09	8,801.59	2,955.24	418.86	349.20	1,882.20	13.88
2033	796.80	8,625.44	2,994.37	420.29	349.61	1,893.83	14.08
2034	806.59	8,308.11	3,033.49	421.62	349.94	1,905.41	14.28
2035	816.35	8,106.58	3,072.61	425.26	352.52	1,916.95	14.48
2036	826.07	7,785.91	3,111.74	426.44	352.69	1,928.43	14.67
2037	835.74	7,493.58	3,150.87	429.96	355.17	1,948.75	14.87
2038	845.38	7,384.11	3,189.99	430.98	355.19	1,960.16	15.07
2039	857.25	7,245.83	3,229.12	434.39	357.55	1,971.52	15.27
2040	869.12	7,113.99	3,268.25	440.27	362.32	1,991.79	15.47

Table B-3. HGB Uncontrolled OSD CMV Emissions, tons per day

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	0.95	31.23	3.29	2.55	2.11	31.48	0.01
1991	0.99	32.30	3.41	2.67	2.21	32.92	0.01
1992	1.05	34.28	3.62	2.80	2.32	34.49	0.02
1993	1.00	30.54	3.30	2.83	2.33	35.29	0.02
1994	1.09	34.55	3.69	3.00	2.47	37.13	0.02
1995	1.15	36.54	3.89	3.13	2.58	38.70	0.02
1996	1.07	31.68	3.44	3.05	2.51	38.11	0.02
1997	1.34	44.55	4.69	3.55	2.95	43.73	0.02
1998	1.33	43.15	4.58	3.59	2.97	44.37	0.02
1999	1.65	64.20	6.47	3.77	3.19	44.87	0.02
2000	1.49	48.96	5.18	3.98	3.30	49.11	0.02
2001	1.39	43.28	4.65	3.86	3.19	48.01	0.02
2002	1.34	41.83	4.49	3.71	3.06	46.13	0.02
2003	1.57	52.53	5.52	4.12	3.42	50.59	0.02
2004	1.45	43.20	4.71	4.15	3.41	51.86	0.02
2005	1.43	39.84	4.44	4.26	3.48	53.59	0.02
2006	1.44	37.85	4.29	4.40	3.58	55.69	0.02
2007	1.38	35.98	4.10	4.27	3.47	54.08	0.02
2008	1.41	38.31	4.30	4.24	3.46	53.53	0.02
2009	1.56	44.13	4.89	4.61	3.77	57.95	0.02
2010	1.74	53.11	5.74	4.86	4.00	60.45	0.03
2011	1.77	54.05	5.85	4.97	4.09	61.87	0.03
2012	1.81	54.98	5.95	5.08	4.18	63.30	0.03
2013	1.84	55.91	6.06	5.19	4.27	64.73	0.03
2014	1.88	56.84	6.17	5.31	4.36	66.15	0.03
2015	1.92	57.76	6.27	5.42	4.45	67.58	0.03
2016	1.95	58.70	6.38	5.53	4.55	69.01	0.03
2017	1.99	59.62	6.49	5.64	4.64	70.43	0.03
2018	2.03	60.56	6.60	5.75	4.73	71.86	0.03
2019	2.06	61.49	6.70	5.87	4.82	73.29	0.03
2020	2.10	62.42	6.81	5.98	4.91	74.71	0.03
2021	2.14	63.35	6.92	6.09	5.00	76.14	0.03
2022	2.17	64.28	7.02	6.20	5.09	77.57	0.03
2023	2.21	65.21	7.13	6.32	5.19	78.99	0.03
2024	2.24	66.14	7.24	6.43	5.28	80.42	0.03
2025	2.28	67.07	7.35	6.54	5.37	81.85	0.03
2026	2.32	68.00	7.45	6.65	5.46	83.27	0.03
2027	2.35	68.93	7.56	6.77	5.55	84.70	0.04
2028	2.39	69.86	7.67	6.88	5.64	86.12	0.04
2029	2.43	70.79	7.77	6.99	5.73	87.55	0.04
2030	2.46	71.72	7.88	7.10	5.82	88.98	0.04
2031	2.50	72.65	7.99	7.22	5.92	90.40	0.04
2032	2.54	73.58	8.10	7.33	6.01	91.83	0.04
2033	2.57	74.51	8.20	7.44	6.10	93.26	0.04
2034	2.61	75.44	8.31	7.55	6.19	94.68	0.04
2035	2.65	76.37	8.42	7.67	6.28	96.11	0.04
2036	2.68	77.30	8.53	7.78	6.37	97.54	0.04
2037	2.72	78.23	8.63	7.89	6.46	98.96	0.04
2038	2.75	79.16	8.74	8.00	6.56	100.39	0.04
2039	2.79	80.09	8.85	8.12	6.65	101.81	0.04
2040	2.83	81.02	8.95	8.23	6.74	103.24	0.04

Table B-4. HGB Controlled OSD CMV Emissions, tons per day

Year	VOC	NO_X	CO	PM10-PRI	PM25-PRI	SO_2	NH_3
1990	0.95	31.23	3.29	2.55	2.11	31.48	0.01
1991	0.99	32.30	3.41	2.67	2.21	32.92	0.01
1992	1.05	34.28	3.62	2.80	2.32	34.49	0.02
1993	1.00	30.54	3.30	2.83	2.33	35.29	0.02
1994	1.09	34.55	3.69	3.00	2.47	37.13	0.02
1995	1.15	36.54	3.89	3.13	2.58	38.70	0.02
1996	1.07	31.68	3.44	3.05	2.51	38.11	0.02
1997	1.34	44.55	4.69	3.55	2.95	43.73	0.02
1998	1.33	43.15	4.58	3.59	2.97	44.37	0.02
1999	1.65	64.20	6.47	3.77	3.19	44.87	0.02
2000	1.49	48.96	5.18	3.98	3.30	49.11	0.02
2001	1.39	43.28	4.65	3.86	3.19	48.01	0.02
2002	1.34	41.83	4.49	3.71	3.06	46.13	0.02
2003	1.57	51.69	5.52	4.10	3.40	50.40	0.02
2004	1.45	42.12	4.71	4.13	3.39	51.66	0.02
2005	1.43	38.54	4.44	4.24	3.46	53.38	0.02
2006	1.44	36.34	4.29	4.38	3.56	55.48	0.02
2007	1.38	34.27	4.10	4.25	3.45	53.87	0.02
2008	1.41	36.36	4.30	4.22	3.44	53.32	0.02
2009	1.56	41.71	4.89	4.58	3.74	57.72	0.02
2010	1.74	48.37	5.74	1.92	1.62	23.01	0.03
2011	1.77	48.65	5.85	1.96	1.65	23.52	0.03
2012	1.80	48.66	5.95	1.99	1.68	24.03	0.03
2013	1.84	48.67	6.06	2.02	1.69	24.55	0.03
2014	1.86	48.26	6.17	2.04	1.71	25.06	0.03
2015	1.88	48.13	6.27	1.13	0.98	4.62	0.03
2016	1.89	47.66	6.38	1.13	0.99	4.63	0.03
2017	1.91	45.96	6.49	1.13	0.98	4.62	0.03
2018	1.92	43.75	6.60	1.13	0.98	4.63	0.03
2019	1.93	41.87	6.70	1.14	0.98	4.68	0.03
2020	1.95	40.26	6.81	1.14	0.99	4.79	0.03
2021	1.96	38.64	6.92	1.14	0.98	4.82	0.03
2022	1.98	37.09	7.02	1.14	0.97	4.83	0.03
2023	1.99	35.04	7.13	1.14	0.97	4.86	0.03
2024	2.00	33.31	7.24	1.14	0.97	4.90	0.03
2025	2.02	31.77	7.35	1.14	0.97	4.93	0.03
2026	2.04	30.28	7.45	1.14	0.96	4.96	0.03
2027	2.05	28.98	7.56	1.14	0.96	5.00	0.04
2028	2.07	27.81	7.67	1.14	0.96	5.03	0.04
2029	2.09	26.58	7.77	1.14	0.96	5.06	0.04
2030	2.11	25.58	7.88	1.15	0.97	5.09	0.04
2031	2.13	24.85	7.99	1.14	0.96	5.12	0.04
2032	2.16	24.11	8.10	1.15	0.96	5.16	0.04
2033	2.18	23.63	8.20	1.15	0.96	5.19	0.04
2034	2.21	22.76	8.31	1.16	0.96	5.22	0.04
2035	2.24	22.21	8.42	1.17	0.97	5.25	0.04
2036	2.26	21.33	8.53	1.17	0.97	5.28	0.04
2037	2.29	20.53	8.63	1.18	0.97	5.34	0.04
2038	2.32	20.23	8.74	1.18	0.97	5.37	0.04
2039	2.35	19.85	8.85	1.19	0.98	5.40	0.04
2040	2.38	19.49	8.95	1.21	0.99	5.46	0.04